TELETYPE

PRINTING TELEGRAPH SYSTEMS

BULLETIN 239B

E TELETYPEWRITER SET AN/FGC-36
(HIGH SPEED PAGE PRINTER)

RIPTION, THEORY OF OPERATION, INSTALLATION
OPERATION, MAINTENANCE AND PARTS LISTS.

CONTRACT NO. DA-36-039-SC-56766

TELETYPE
CORPORATION
SUBSIDIARY OF
Western Electric Company
CHICAGO, U.S.A.

MP MASTER
MA31860

TELETYPE

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SECTION I

GENERAL DESCRIPTION

1. GENERAL

a. Scope of Manual

This manual describes the AN/FGC-36 Page Teletypewriter set and includes information concerning its purpose, description and theory of operation, installation, operation, maintenance and parts list.

b. Purpose of the Equipment

The AN/FGC-36 Page Teletypewriter Set is used to exchange typewriter page messages between two or more distant points when connected by a telegraph channel, and to record information received at high speed on a multiple wire basis from such devices as computers. The operating speeds are 368.1 opm (60 wpm), 404 opm (66 wpm), 460 opm (75 wpm), 600 opm (100 wpm), 1440 opm (250 wpm) and 4500 opm (750 wpm) as desired. Signaling on line between stations is accomplished electrically by use of the five unit start stop permutation code, signals originating from either keyboard or reader. For off line communications, 5 wire signaling is employed. Messages are typed on either single or multiple copy paper, eight and one half inches wide.

The equipment will operate on either .060 or .020 ampere line current and adaptation to either is accomplished by means of a convenient switch.

Certain functions, namely carriage return, shift and space are performed completely electronically while line feed is done mechanically, as are keyboarding and printing.

2. DESCRIPTION OF COMPONENTS

a. Printer Set (Fig. 1-1 and 1-2)

The printing portion of the set is housed in the operator's cabinet at the right.

(1) Keyboard (Fig. 1-1, 1-3, 1-4)

A keyboard for manual sending is provided and occupies the conventional position below the typing unit.

(a) Manual operation of the keyboard generates code permutations, that upon delivery to the electronic transmitting distributor in the associated Electronic Control System result in the transmission of 7.42 unit start-stop signals. Each code level operates a code contact that is associated with a diode 32 to 5 converter on the keyboard. The 32 to 5 converter sends combinations of five (5) parallel code pulses to the transmitting distributor. In addition to the code, the keyboard also generates start control and storage release pulses with the depression of each character key.

(b) Miscellaneous local function keys with contacts are also provided.

(c) For use in receiving only applications, a base frame without the character keys, contacts, and converter are provided.

(2) Typing Unit (Figs. 1-3, 1-4)

The Typing Unit operates in association with the High Speed Page Printer Electronic Control System and the Keyboard Base Unit. Its function is to receive electrical printing pulses from the Electronic Control System and to cause the character corresponding to the pulses to be printed in proper sequence on 8-1/2" wide roll paper. This it does through the medium of 78 printing magnets and associated mechanisms, one for each column of characters to be printed, together with a common motor-driven impeller and type-cylinder. The Typing Unit also contains the paper feeding and guiding mechanism, the ribbon driving mechanism, and the pulse generator index wheel, which steps the binary counter in the Electronic Control System in accordance with the angular position of the continuously rotating type cylinder.

The Typing Unit is mounted on the Keyboard-Base Unit and receives its motive power from the motor in that Unit through a toothed-belt drive. The Typing Unit and Keyboard-Base Unit together are mounted in the Printer Cabinet, and are connected by cables to the Electronic Control System.

(3) Printer Cabinet (Fig. 1-3)

(a) The general function of the High Speed Page Printer Cabinet is to house a Send-Receive or Receive Only printer set.

(b) The cabinet is similar to that of the Model 28 Page Printer console, and stands 38-1/2" high, 20-1/2" wide and 18-1/2" deep.

(c) All of the mechanism for the keyboard and typing unit are mounted within this cabinet, which is cable connected to the associated Electronic Control Cabinet beside which it stands.

(4) Electronic Control System (Fig. 1-5, 1-6)

The High Speed Page Printer Electronic Control System operates in association with the High Speed Page Printer Typing and Keyboard Units. Its function is to provide electrical printing pulses which are received by the Typing Unit and there converted to the mechanical action necessary for the preparation of page copy. All distributing, selecting and control are performed electronically using transistors for the majority of the circuits.

The system is housed in its own cabinet and the various units are assembled as individual drawers.

The several units comprising the system are:

(a) A Transmitting Distributor, which receives code pulses from the keyboard, feeds these into storage elements, and generates start stop signals.

(b) A Receiving Distributor, which accepts the signals, converts them from serial to parallel and delivers them to the 3 Storage and Character Recognition Units and the Control Unit.

(c) A, B & C Storage and Character Recognition Units which accept the code combinations from the receiving distributor unit, recognize the character and deliver a firing pulse to the proper Thyratron Print Circuit.

(d) A Control Unit, whose main function is to determine which of the Storage Units A, B or C is to receive the code pulses from the Receiving Distributor.

(e) A Binary Counter which informs the Storage and Character Recognition Unit as to which character on the type wheel is in printing position.

(f) Thyratron Print Circuits which energize the selector magnets on receipt of character recognition pulses from the Storage and Character Recognition Unit.

(g) A Power Supply, which contains the necessary rectifier and regulating circuits.

(5) Electronic Control System Cabinet (Figs. 1-5, 1-6)

(a) The High Speed Page Printer Electronic Control System Cabinet is designed to house the electronic elements of this equipment. The cabinet is a free standing unit approximately 36" high, 21" wide and 25" deep with all operating controls at the front. To be set on the floor along side the page printer it controls, it is connected to the latter by means of electrical cables.

Use is made of drawer type construction to provide maximum accessability for assembly and maintenance.

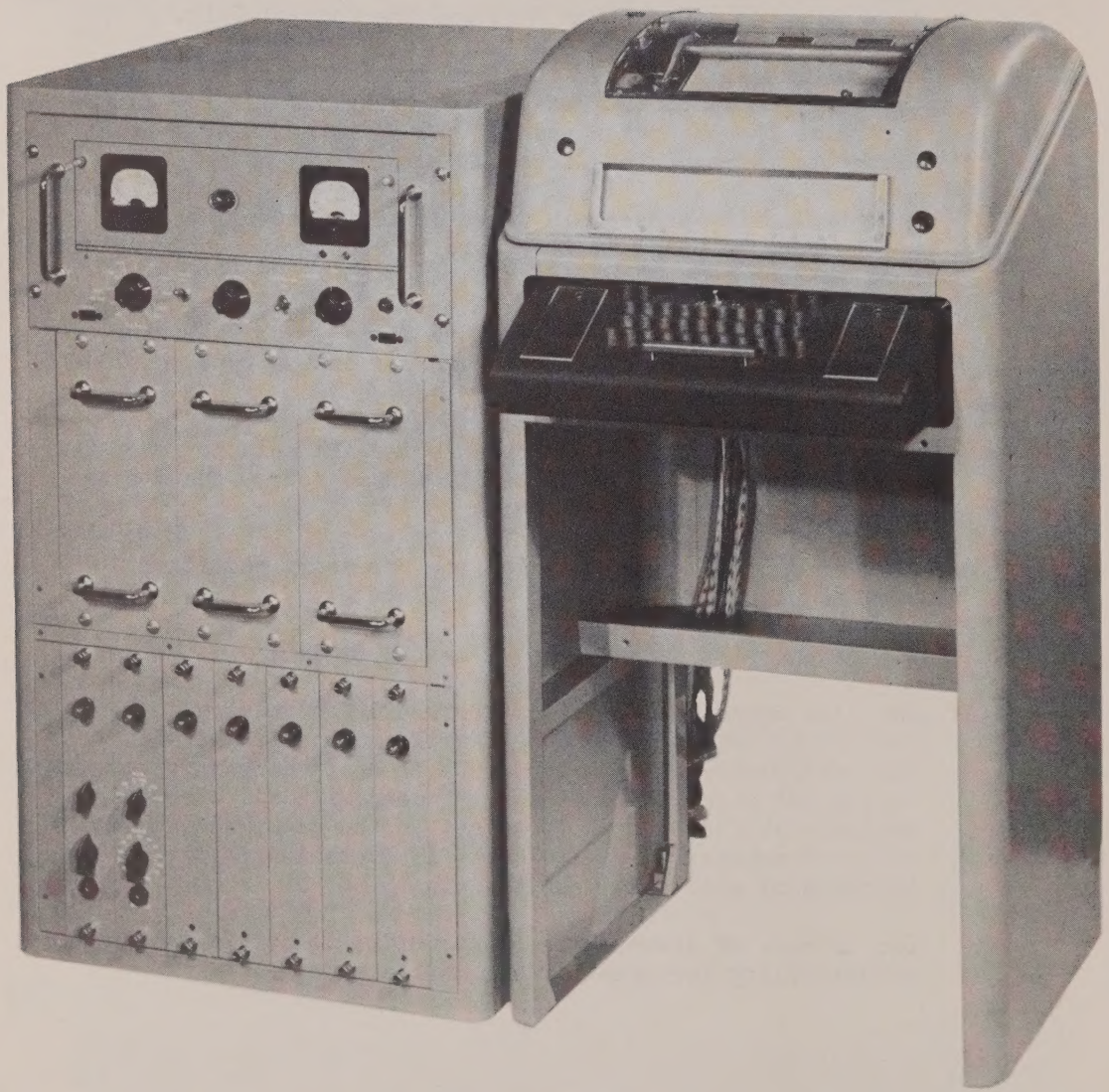


FIG. 1-1
TELETYPEWRITER SET AN/FGC-36 FRONT VIEW

FIG. 1-2
TELETYPEWRITER SET AN/FGC-36 REAR VIEW

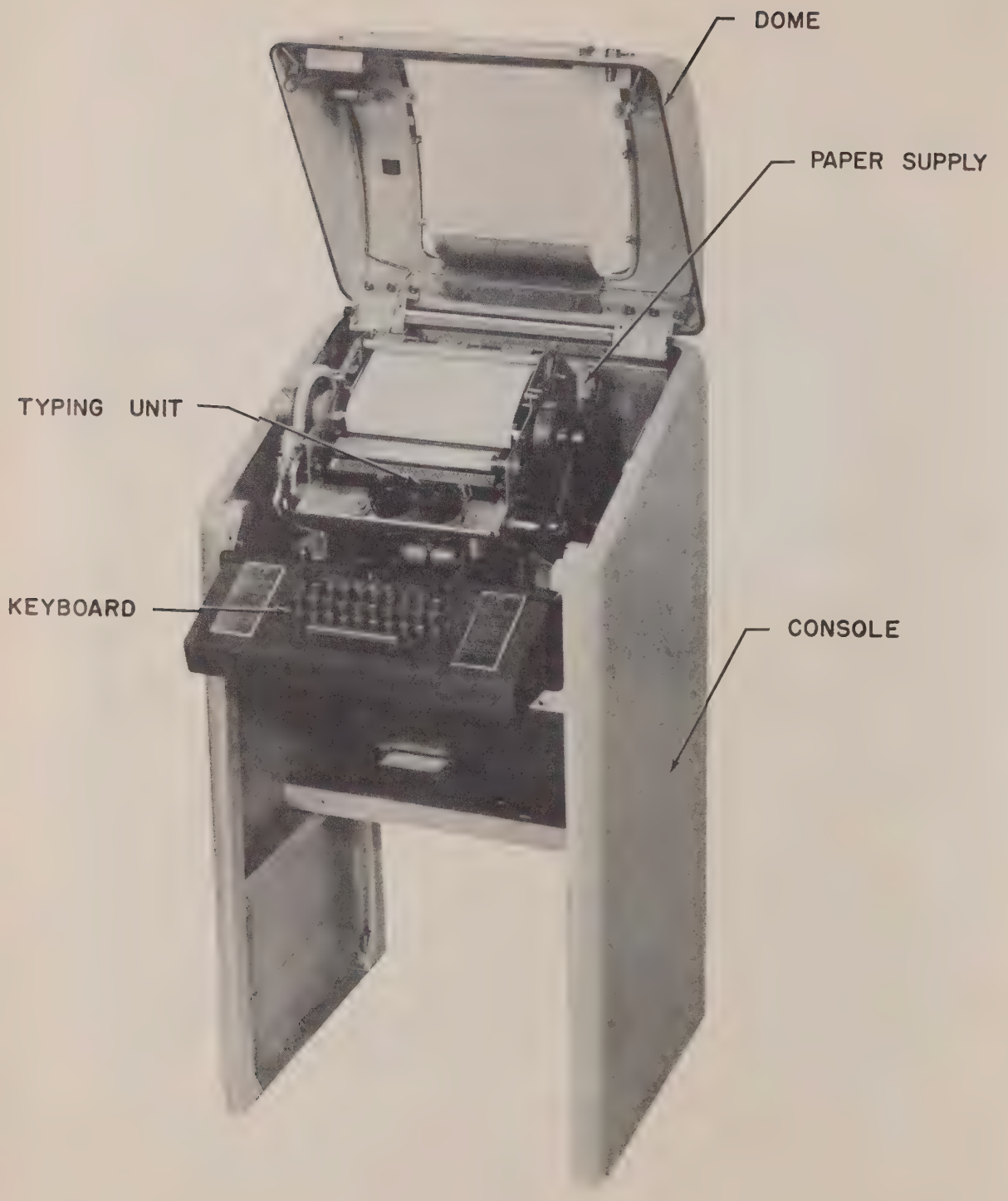


FIG. 1-3
PRINTER, CONSOLE, TYPING UNIT, & KEYBOARD

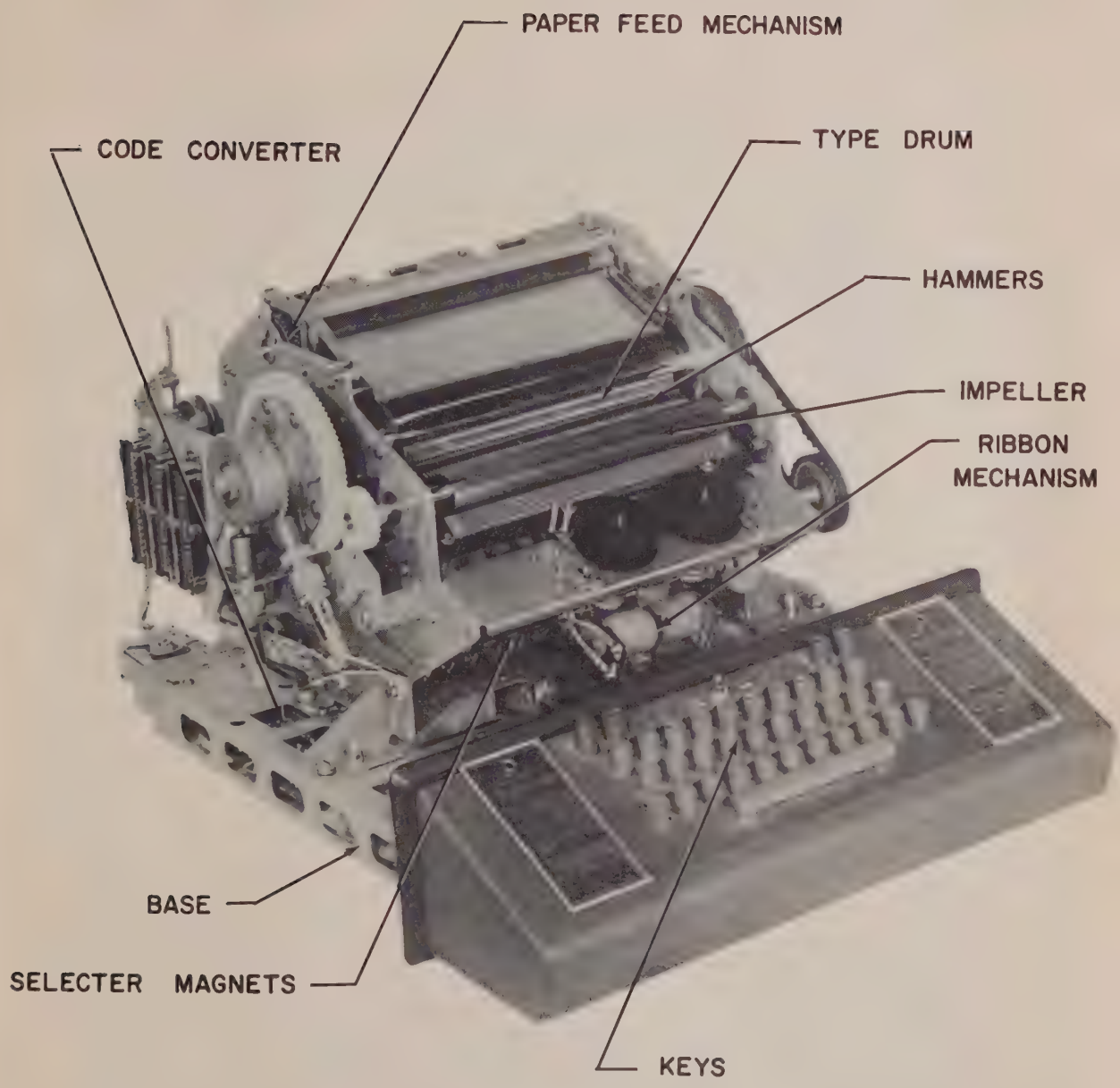


FIG. I-4
TYPING UNIT & KEYBOARD

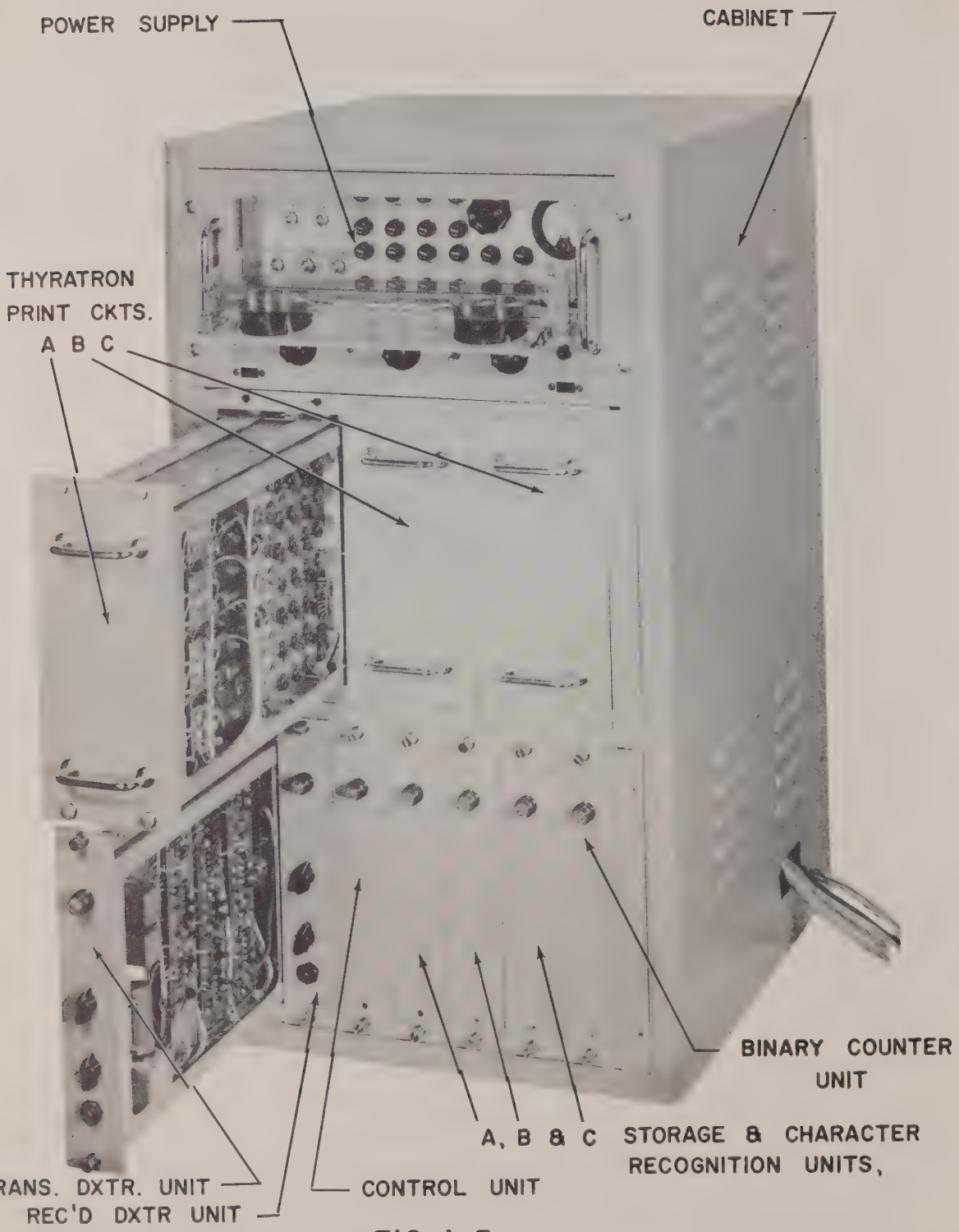


FIG. I-5
ELECTRICAL UNITS & CABINET

FIG. I-6
ELECTRICAL UNITS & CABINET, REAR VIEW

SECTION II

DETAILED DESCRIPTION AND THEORY OF OPERATION

A. GENERAL

1. This section covers the complete experimental high speed printer system which includes Keyboard, Electronic Transmitting Distributor Unit, Electronic Receiving Distributor Unit, Storage and Control Units, and Printer. Keyboard and Printer are covered in Sections II B and II C respectively. The electronic units (including basic circuits) are described in Section II E of this bulletin. Certain features of the Keyboard and Printer which are necessary for the System description will be presented; however, for detailed information, Sections B and C should be consulted.

2. The system is a keyboard-sending page-receiving teletypewriter set designated AN/FGC-36. In order to enable high speed operation (up to 750 wpm) of the receiving portion, electronic techniques are used wherever possible. The Printer and Keyboard are the only mechanical units in the system. All distributing, selecting, and control are performed electronically, using transistors for the majority of the circuits. (See Figure 2-0)

3. The Keyboard Unit puts out combinations of five (5) parallel code pulses plus a control pulse to the Electronic Transmitting Distributor Unit, which performs a parallel to serial conversion and adds the start and stop pulses. In addition, the two units cooperate to provide Repeat and Signal Line Break features. The Keyboard is also provided with local carriage return and line feed keys. The Receiving Distributor accepts the serial start-stop signal from the transmitter, converting it back to a parallel code combination. This parallel signal is fed to the Storage and Control Units which (1) recognize functions (2) cooperate with the printer to select the character to be printed.

4. Printing is accomplished on-the-fly with 78 continuously rotating type wheels and 78 print hammers. Each print hammer mechanism is tripped by its respective electro-magnet which is energized at the right time by the Storage and Control units. The hammer is propelled against the rotating type wheel by motor power in a regenerative action that provides close timing and, thus, accurate registration of the printed character. In the AN/FGC-36, only 75 magnet connections are used, limiting the set to a 75 character line.

5. The basic operating speed of the printing mechanism is 250 wpm. Three separate storage positions enable the printing of three characters in one revolution of the type wheels, thereby providing a maximum speed of 3 x 250 or 750 wpm.

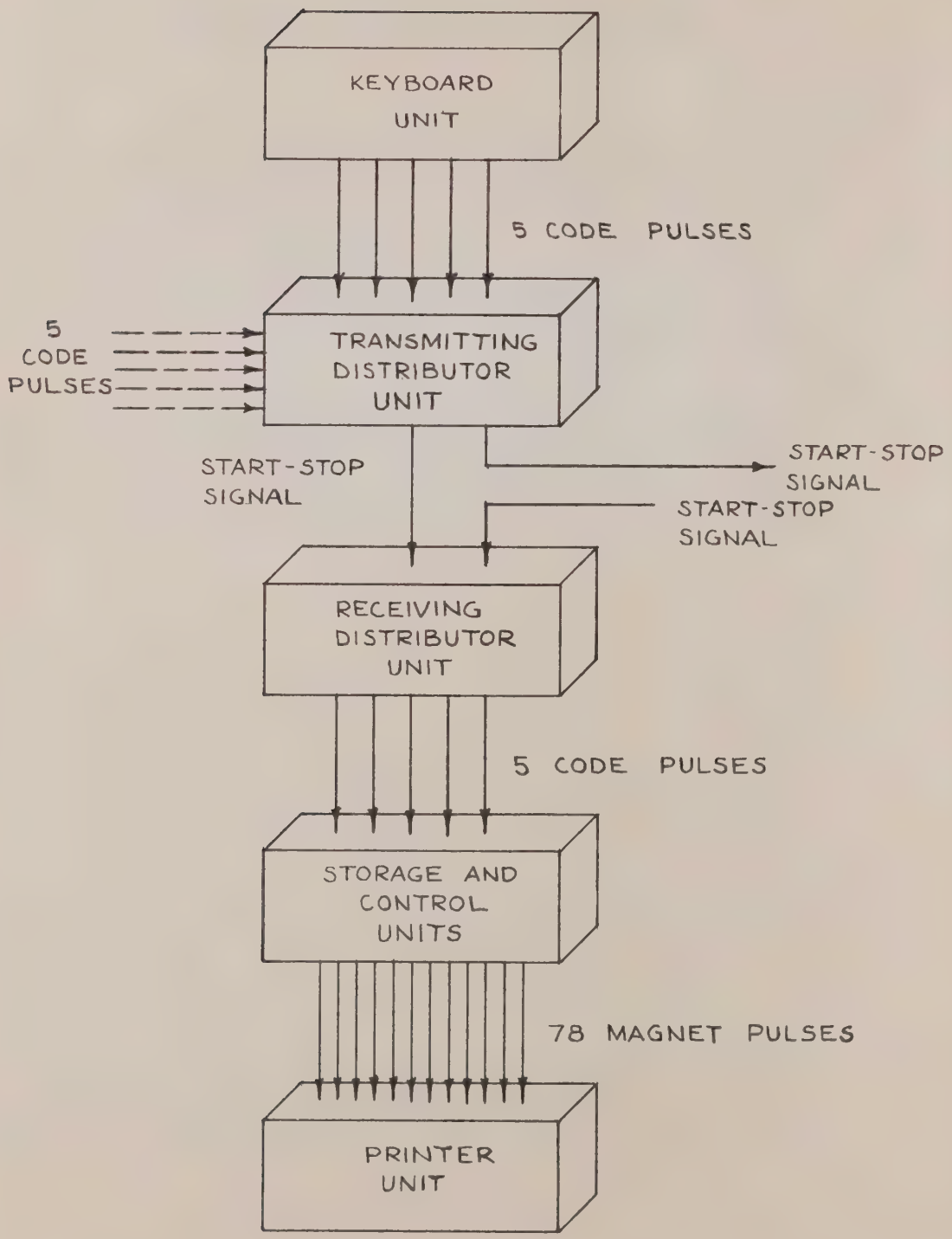


FIGURE 2-0
FUNCTIONAL BLOCK DIAGRAM OF AN/FGC-36

B. KEYBOARD

1. DETAILED DESCRIPTION

a. General

(1) The external appearance and dimensions of the Keyboard are similar to the Model 28 Page Printer Keyboard. For "receive only" operation, the Keyboard Base is replaced by a similar unit having no keys or signal transmitting components.

b. Keyboard Arrangement (Fig. 2-1)

(1) The code sending keys are arranged in a standard three bank arrangement with numerals and punctuation in the upper case position and the alphabet in the lower case position. A space bar extends across below the lower row of code keys. Special keys for local line feed, break, local carriage return, and repeat are located directly above the code sending keys, with local line feed and break on the left and local carriage return and repeat on the right. An SPST toggle switch, used to engage or disengage automatic line feed with the localcarriage return function, is located in the center between the two groups.

c. Keyboard Mechanical Arrangement (Fig. 2-2)

(1) Each code sending key (1) is attached to a code lever (2) that projects into a base (3). A ball lock mechanism (4), from the Model 28 Keyboard, is used as the keyboard lock preventing the depression of more than one key at any one time. Directly above the other end of the code levers are code lever contacts (5) with one SPST contact in line with each code lever. Each upper contact (6) representing a character is connected to one of the 32 inputs of the 32 to 5 diode converter (7). Upper contacts (6) representing local carriage return, local line feed, break, and repeat are connected to their respective circuits. Lower contacts (8) are electrically joined together to a +12 volt potential.

(2) Attached to a code bail (9) are two contact actuators (10 and 11), a leaf spring (12), a bail stop projection (13), and a latching magnet armature (14). The contact actuators mounted side by side, close two SPST contacts (15) located inside the base (3) behind the code lever bail. The actuator (10) on the left closes a storage release contact (15) and the actuator (11) on the right closes a start control contact (15). Mounted on the top surface of the base is an adjustable damping bracket (16) adjacent to the leaf spring, a stop bracket (17) in line with the bail stop projection, and a latching magnet (18) directly behind the latching magnet armature.

(3) A 3600 rpm synchronous motor (19), used to drive the printer mechanism, is mounted on a plate (20) located on the right in the rear center compartment of the base (3). The motor is connected to a 60 cycle 115 volt source thru a 24 terminal male connector (21) mounted at the left rear of the base. In front of the motor and mounted in the center left compartment of the base is the motor stop relay (22). The magnet is connected to the motor stop amplifier and a 45 volt source in the associated Control Unit thru the 24 terminal male connector. The motor start relay, capacitor, and thermal cutout switch assembly (23) is mounted in the right rear compartment of the base and is also connected into the motor circuit.

(4) A 16 terminal male connector (21), is mounted on the connector bracket to the right of the 24 terminal male connector (21).

d. 32 to 5 Diode Converter (Fig. 2-2)

(1) The converter (7) is composed of 58 silicon diodes mounted on two terminal boards (24) stacked one on top of the other and mounted in the left rear compartment of the base (3). The 32 inputs are connected to the individual character code lever contacts (6) by means of a cable (25) mounted along the inner left side of the base. The five outputs connect to the 24 terminal male connector (21).

e. Receive Only Base (Fig. 2-3)

(1) The Receive Only Base is used in place of the Keyboard when receiving only facilities are required. Controls on the front panel provide for local carriage return, local line feed, and an SPST toggle to engage or disengage automatic line feed with the local carriage return function.

(2) The 3600 rpm synchronous motor is mounted and connected as described in paragraph 1.c. (3).

2. THEORY OF OPERATION

a. Operational Sequence - Character Selection

(1) Key Selection (Fig. 2-2)

(a) The selection of a character output signal is controlled by the depression of the corresponding key (1). The linkage of each key to its corresponding code lever (2) produce a rotation of the latter about the code lever shaft (26) for any downward displacement of the key. When the code lever revolves thru an angle of three degrees, it comes into contact with the code lever bail (9). Further rotation produces movement of the bail, closure of contacts (15) and closure of a contact (5).

(2) Storage Release Contact [1*]

(a) When the code lever bail (9) is rotated 10 degrees from the horizontal, the storage release contact (15) is closed by actuator (10), putting out a positive 12 volt pulse. The pulse is used to clear the previously selected character out of the storage flip-flop circuits in the Transmitting Distributor Unit.

(3) Code Lever Contact

(a) When the code lever bail (9) reaches the 15 degrees position, the selected code lever (2) closes its code lever contact (6), sending a positive 12 volt pulse to the corresponding input in the 32 to 5 converter (7).

(4) Start Control Contact [1]

(a) When the code lever bail (9) reaches the 25 degrees position, the start control contact (15) is closed by actuator (11), sending a +12 volt pulse into the start control flip-flop. This starts the transmitting distributor which in turn energizes the latching magnet (18). When the code lever bail is in the latched position, the selected key (1) is locked in the "down" position by the lower projection of the bail (9) until the transmitting distributor has completed the transmission of the character and de-energizes the latching magnet. At that time, spring (27) on the code lever (2), and spring (28) on the code lever bail (9), return the mechanism to its original position, ready for the next selection.

(5) Non-Repeat Function [1]

(a) Closure of the storage release contact (15), the code lever contacts (6), and the start control contact (15), produces positive pulses whose lengths are dependent upon how long the key (1) remains depressed. To achieve non-repeating, coupling capacitors, in the associated Transmitting Distributor Unit, are placed between the contacts and their respective circuits so that a positive pulse is provided only at the moment of closure of each contact. This allows removal of key pressure by the operator at will after the key is initially depressed, and requires complete release and reoperation of the key if the character is to be repeated. The ball lock (4) prevents more than one key from being depressed at any one time.

(6) Bail Bounce Damping

(a) The return of the code lever bail (9), from the latched position to its normal nut position, is controlled in part by the action of the leaf spring (12) against the felt lined damping bracket (16). A sudden release of the bail from the latched position developes a high energy level that is partially absorbed by the damping device as the bail rotates toward its normal rest position. This prevents the possibility of a second

*Numerals indicate references listed at end of section.

closure of the storage release contact (15) due to a bounce of the bail off of the stop bracket (17).

b. Operational Sequence - Non-Character Selection (Fig. 2-2)

(1) Repeat Function [1]

(a) The repeat key, one of local function keys (29), is attached to a code lever (2) which has no rear extension to engage the code lever bail (9). The only function of this code lever is to close its code lever contact (6), sending a positive 12 volt pulse into the repeat circuits in the Transmitting Distributor Unit. The last character put into storage is then automatically as long as the key is kept depressed.

(2) Break Function [1]

(a) The break key (29) is attached to a similar short code lever. Its function is to close the code lever contact (6) and send a positive 12 volt pulse into the line relay circuit of the Transmitting Distributor Unit, causing it to send the spacing (open line) signal as long as the key is kept depressed.

(3) Local Carriage Return Function [1]

(a) The local carriage return key (29) is also attached to a short code lever (2). This code lever closes the code lever contact (6), sending a positive 12 volt pulse into the parallel carriage return and line feed circuits. An SPST toggle switch (30), located between the local keys (29), is placed in series with the line feed circuit, enabling operator choice as to whether line feed occurs automatically with local carriage return or not.

(4) Local Line Feed Function [1]

(a) The local line feed key (29) is also attached to a short code lever (2). This code lever closes the code lever contact (6) sending a positive 12 volt pulse into the line feed circuit of the control unit. This action initiates line feed with control of single or double line feed selection determined by the position of the line feed toggle switch in the Control Unit.

c. 32 to 5 Diode Converter (Fig. 2-4)

(1) The converter contains 58 diodes in an encoding network for the conversion of 32 separate character inputs into the proper five unit coded permutations. The input potential to the converter is +12 volts. The selection of an input terminal is determined by the depression of any character key, closing its corresponding code lever contact. The five unit output is fed in parallel into the five flip-flop circuits in the Transmitting Distributor Unit, and appears as positive 12 volts for marking pulses and zero volts for spacing pulses.

d. Synchronous Motor Unit

(1) The synchronous motor (19) is for use with single phase, 60 cycle, 115 volt alternating current. The motor start relay, capacitor, and thermal cutout switch assembly (23) is used in the motor circuit to provide proper starting conditions and to prevent damage to the motor due to overloading or overheating.

(2) A safety interlock is provided thru the use of the 15 terminal connector (21). This prevents the operation of the motor (19) until the 16 terminal female connector on the Typing Unit is plugged into the male receptacle on the base.

e. Motor Stop Function [2]

(1) Upon receipt of the letter "H" combination with the Electronic Receiving Section in the "Figures" position, the motor stop relay (22) is energized by the motor stop amplifier thru the control of the motor stop storage flip-flop. This action breaks the motor circuit and keeps it open as long as the relay remains energized. Receipt of a marking line signal following a line break signal of more than .165 second results the storage flip-flop which in turn starts off the amplifier, de-energizes the relay, and allows the motor to start.

1) Reference - Electronic Transmitting Distributor Unit, II; E; 1; c; (1)

2) Reference - Electronic Control System, II; E

NOTE 1: 151--- NUMBERS AND E-974-- NUMBERS REFER TO TELETYPE PART NUMBERS OF KEYTOPS AND SPACE BAR

NOTE 2: NUMBERS IN BRACKETS (------) INDICATE MARKING CODE PULSES IN START STOP SIGNAL TRANSMITTED WHEN KEY IS DEPRESSED

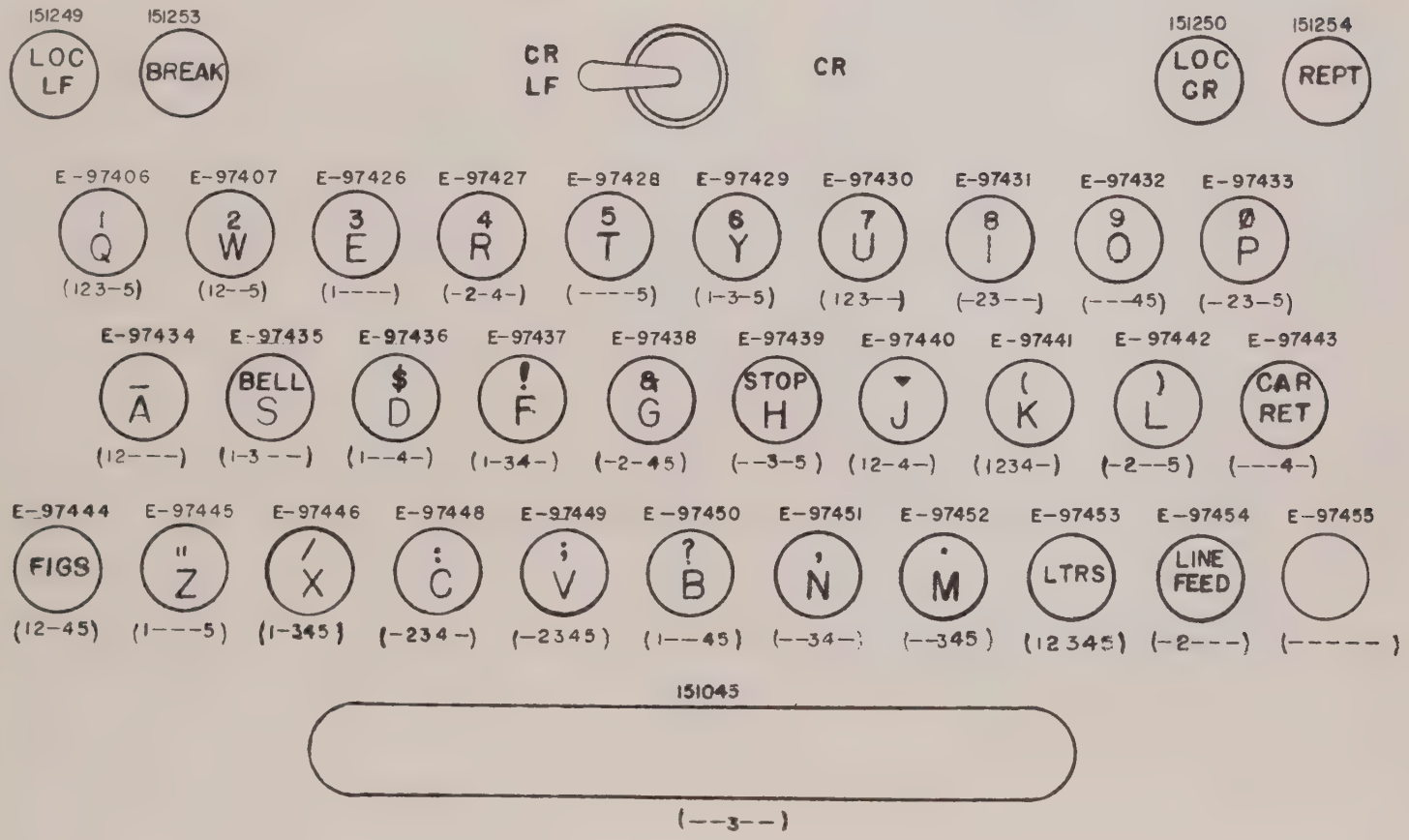


FIGURE 2-1

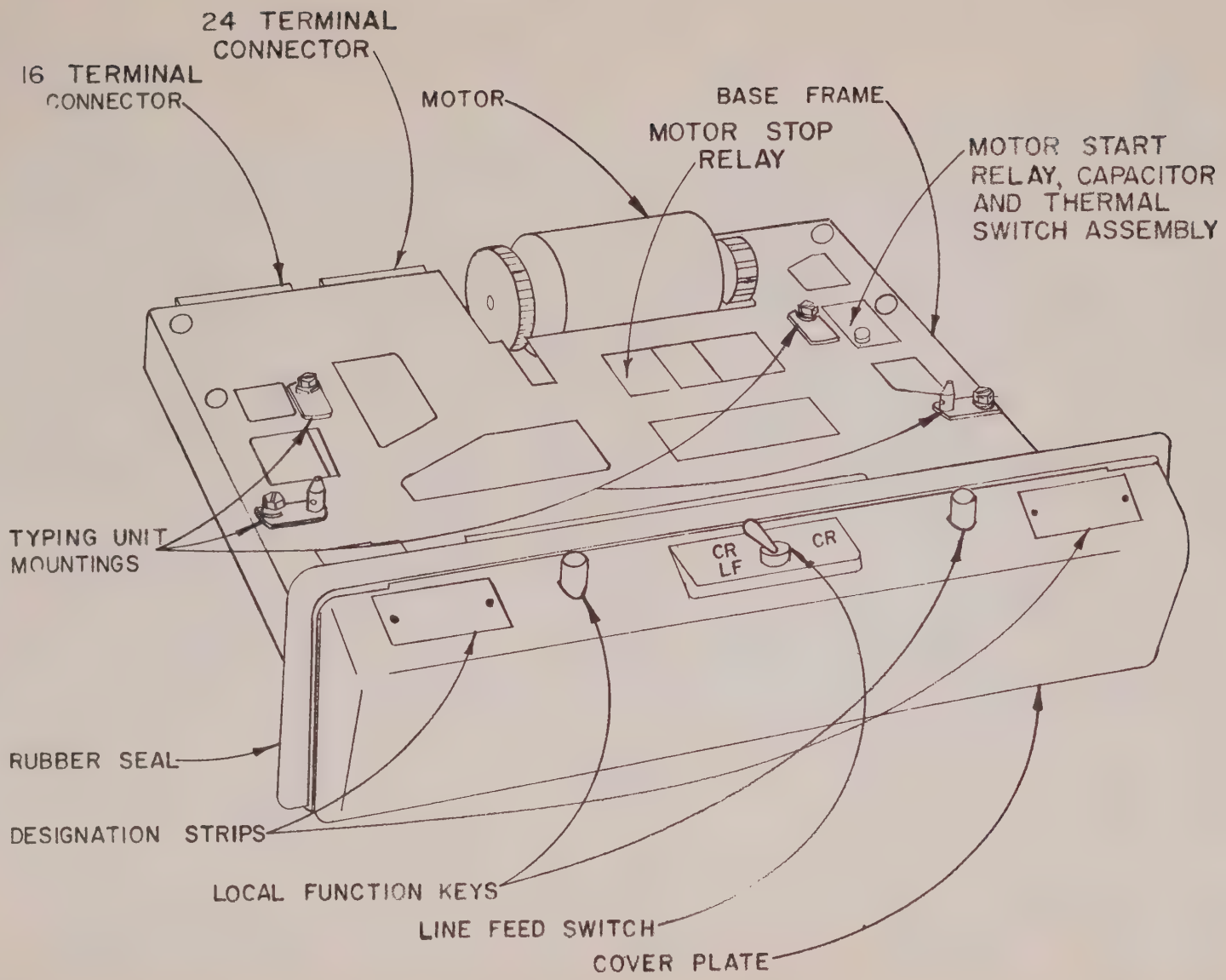
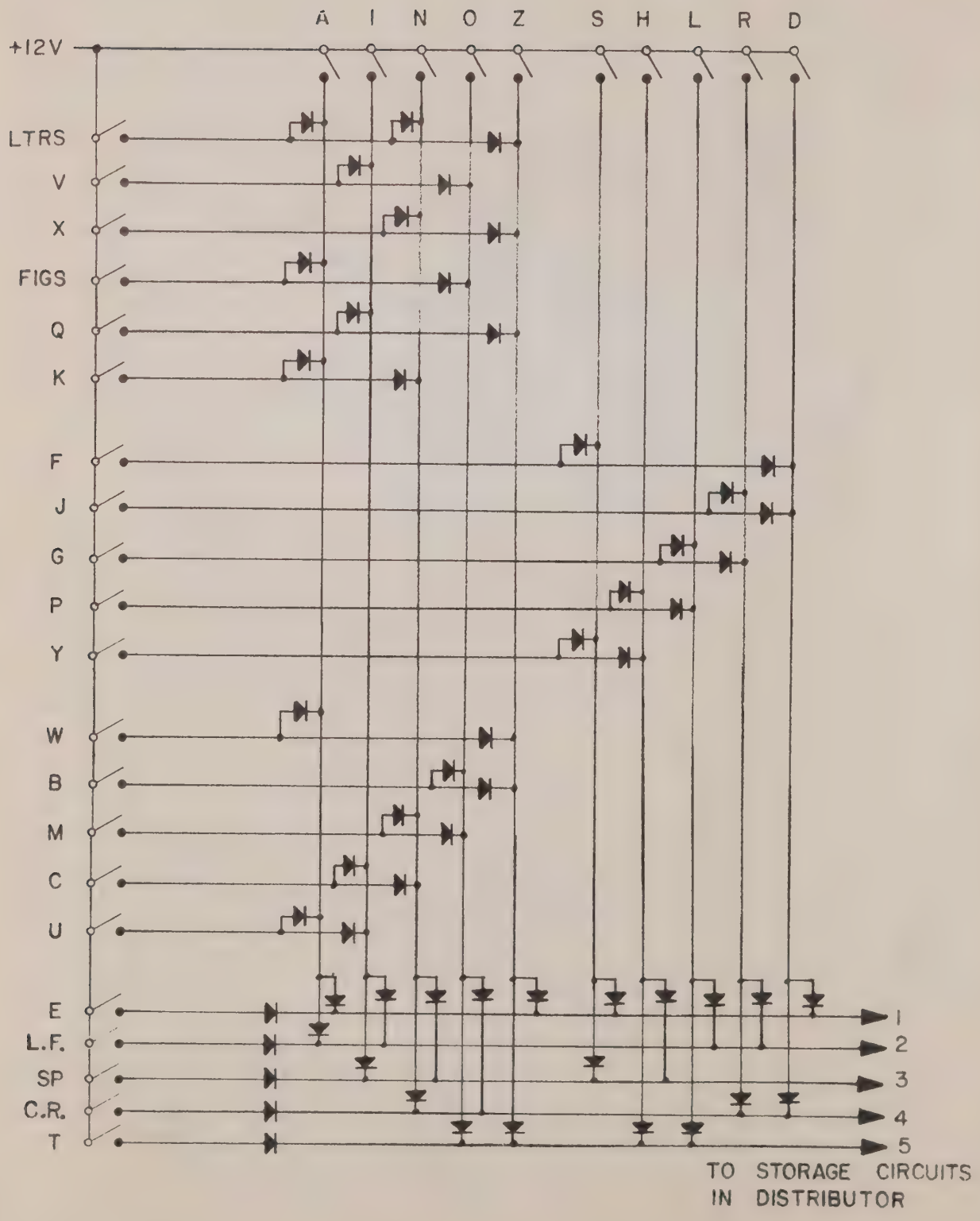

24 TERMINAL CONNECTOR
16 TERMINAL CONNECTOR
MOTOR
BASE FRAME
MOTOR STOP RELAY
MOTOR START RELAY, CAPACITOR AND THERMAL SWITCH ASSEMBLY
TYPING UNIT MOUNTINGS
CR LF
CR
RUBBER SEAL
DESIGNATION STRIPS
LOCAL FUNCTION KEYS
LINE FEED SWITCH
COVER PLATE

Fig. 2-3

FIGURE 2-4


A I N O Z S H L R D
+12V
LTRS
V
X
FIGS
Q
K
F
J
G
P
Y
W
B
M
C
U
E
L.F.
SP
C.R.
T
1
2
3
4
5
TO STORAGE CIRCUITS
IN DISTRIBUTOR

C. TYPING UNIT

1. DESCRIPTION

a. The High Speed Page Printer Typing Unit consists of two side plates on which are mounted the following:

(1) Printing mechanism, consisting of the type wheel assembly, the impeller, and the pawl magnet assembly.

(2) Index wheel and magnetic pickup assembly.

(3) Ribbon feed mechanism.

(4) Paper roll spindle, paper snubber, and paper guides.

(5) Paper feed mechanism.

2. THEORY OF OPERATION

a. Printing Mechanism (Figure 2-5)

(1) The type wheel shaft (1) rotates continuously at 1600 rpm, being driven from the motor through a toothed-belt drive. To the shaft are keyed 78 identical type wheels (2), one for each column of characters which may be printed. Each typewheel has 52 character positions on its periphery, each character occupying the same angular position relative to the shaft on all 78 wheels.

(2) The impeller (3) is geared to the type wheel shaft and rotates continuously at 5200 rpm. It has 16 teeth, and its speed relative to the speed of the type wheel shaft is in the ratio 52/16; consequently, its teeth pass a given point with the same frequency as do the characters on the type wheel. The function of the impeller is to impart a high velocity to the printing hammer when a pawl is interposed between the hammer and one of its teeth.

(3) The paper (4) and ribbon (5) are positioned between the type wheel assembly and a row of 78 printing hammers (6), one hammer opposite each type wheel. The hammers are supported by the guides (7) and are normally held in the retracted position by the springs (8). Adjacent to the 78 hammers is a row of 78 pawls (9) any one of which can be brought forward into the path of the impeller teeth by energizing its respective magnet (10). The pawls are coupled to the magnet armatures (11), through the links (12), to which they are pivotally connected. This connection allows the pawls to rotate counterclockwise when struck by one of the impeller teeth, and to strike the corresponding hammers.

(4) The magnets are disposed in seven banks, one of which carries twelve coils and the other eleven coils each. Each bank consists of a cross bar of angle section which constitutes the common return for all magnetic circuits in the bank, and to which are attached the individual laminated cores. It serves also as the armature fulcrum and the armature spring support.

(5) Each armature carries an extension arm (13) which connects it to the link (12). The extension is attached to the armature by two screws, (14). By loosening one screw and tightening the other the air gap may be adjusted to the correct amount. The links (12), although of different lengths, are designed to be approximately equal in mass, so that the inertia load is approximately the same on all magnets, and thus they will have nearly uniform operating speeds.

(6) When a character is to be printed, the control unit energizes the magnet which corresponds to the column in which the character is to be printed (See Section II.D). The energizing pulse results from the discharge of a capacitor through the magnet coil and has the shape of one-half cycle of a damped sine wave. Its duration is about 1.0 millisec. The time of release of the pulse determines which of the 52 characters will be printed.

(7) Upon being energized, the magnet attracts its armature, moving the pawl (9) upward into the path of the impeller teeth. Although the pulse dies away after 0.5 millisec. the armature, link and pawl continue moving under their own momentum until a projection on the link (12) strikes the guide (15). This occurs after about 2.0 milliseconds. Thereupon the armature, link, and pawl, rebound back to the rest position, where they are held by the armature spring (16).

(8) The period of time during which the pawl is in the path of the impeller is about 1 millisec. During this time the pawl is struck by a tooth and driven counterclockwise at high velocity against the hammer. Upon being struck by the pawl the hammer is driven toward the ribbon and paper at a velocity approximately the same as the original velocity of the pawl, makes the printing impression at the instant the character on the type wheel is in position under it, and rebounds toward its rest position. Meanwhile, the pawl, after striking the hammer, continues to follow along behind it at about 40% of its original velocity. The hammer, rebounding from the paper, reaches a point about half way back to the rest position before coming again into collision with the pawl. The effect of this impact is to bring the hammer momentarily to a dead stop; it is then returned to rest position by the hammer spring. The pawl is driven backward at a reduced velocity, reaching its rest position approximately four milliseconds after the original impact with the impeller. By this time the pawl has been retracted by the armature spring.

(9) The time elapsing between the impeller blow and the printing impression is approximately 0.8 millisec. So that the character on the type wheel will be positioned under the hammer at the instant of printing, it is necessary to establish the correct angular relationship between the type wheel character and the impeller tooth.

This is adjusted by means of an eccentric 16a, Figure 2-6, on the impeller driving gear on the type wheel shaft, In order to compensate for station-to-station variations in the velocities of the pawl and hammer, each pawl is provided with an adjustable rest (17). Adjusting the rest rightward by loosening the right hand screw and tightening the left hand screw, causes the pawl to be struck sooner; adjusting it leftward causes the pawl to be struck later.

b. Pulse Generator (Figure 2-6)

(1) In order that the control unit may deliver the printing pulses to the pawl magnets at the proper time, it must be informed at every instant of the angular position of the type wheel. For this purpose, a pulse generator is provided consisting of a rotor (18), mounted on the type wheel shaft, and three adjustable magnetic pickups (19). The output of the pickups consists of a succession of pulses that are fed into the six-stage binary counter in the Control Unit and which step the counter successively through each of its 64 code combinations.

(2) The rotor (18) has three rows of teeth on its periphery. The inner row has 52 equally spaced teeth, corresponding to the 52 character positions on the type wheel. The middle row has ten teeth that serve to introduce additional pulses to step the binary counter past those code combinations that do not correspond to characters to be printed. The outer row has one tooth, the purpose of which is to set the binary counter back to zero at the proper point in each printing cycle.

(3) The three pickups (19), one for each row of teeth on the rotor, are adjustable in both angular and radial directions.

(4) The angular relationship between the rotor and the impeller is adjustable by means of an eccentric (20).

c. Ribbon Mechanism (Figures 2-7 and 2-8)

(1) The ribbon spools are driven continously from the type wheel shaft through a toothed-belt drive and countershaft which is geared to the ribbon spool shaft (21). The latter shaft, having the ribbon spool drive pinions (22) on it, has two operating positions, and is constrained to occupy one or the other of these positions by the spring-loaded detent lever (23). When in the right-hand position, the shaft engages with the left ribbon spool gear (24); when in the left-hand position it engages the right ribbon spool gear (25).

(2) Reversal of the ribbon is accomplished by shifting the ribbon spool shaft from one of its two positions to the other. This is done by energizing one or the other of the ribbon reversing magnets (26), whereupon the armature (27) is attracted to this magnet and carries the shaft over with it.

(3) Associated with each magnet is a normally open switch (28) and a switch lever (29). The lever has a fork through which the ribbon passes. When the reversing eyelet in the ribbon engages this fork, the lever is pulled over, closing the switch and energizing the magnet from the 110 volt A.C. source. This shifts the ribbon spool shaft and reverses the direction of the ribbon travel. The eyelet moves back, releasing the switch lever, the switch opens, and the magnet is then de-energized.

(4) Each ribbon spool spindle has a flange (30) which turns against a felt friction washer (31). Pressure is maintained against the washer by a spring (32). Thus, a drag is maintained on the ribbon spool while the ribbon is being unwound from it, and by this means tension is maintained in the ribbon. When the spool is being rotated by the driving pinion, it is raised slightly so that the flange does not rest on the felt washer; thus the drag is present only on that spool from which the ribbon is being unwound.

(5) The ribbon spool spindles are driven at a constant speed of 61.5 rpm, giving the ribbon an average speed of about four inches per second past the printing positions.

(6) The ribbon is supported by six rollers (33). It is positioned between the print hammer and the paper in order that the printed characters will appear on the outside surface of the paper and thus be visible.

(7) Space (34) is provided at the left side of the ribbon mechanism for a ribbon re-inking device.

d. Paper Feed (Figure 2-9)

(1) Paper is stored in a 5 inch diameter roll (35) which is mounted on the spindle (36). The spindle is supported by two brackets (37) and held in place by two sliding latches (38) which may be drawn back for the purpose of removing the spindle to insert a new roll of paper. On one end of the spindle is a brake drum (39) against which the brake shoe (40) bears, being held in contact by the spring (41) and the lever (42). The purpose of the brake is to prevent the paper roll from overtraveling and causing the paper to go slack at the printing position.

(2) Upon leaving the roll, the paper goes under the snubber (43). The spring (44), acting through the snubber, plus the weight of the snubber, keeps the paper constantly in tension. On the snubber arm is a cam surface (45) which engages the lower end of the brake lever (42). Feeding paper through the printer causes the snubber

arm to rise, until, at the mid-point of its travel, it lifts the brake shoe away from the drum and permits the paper roll spindle to turn under the tension in the paper. If paper is being rapidly fed out, the snubber will be raised above the mid-point, further stretching springs (41) and (44), thus putting more tension in the paper and accelerating the unwinding of paper from the roll. As the paper unwinds, the snubber arm (43) drops, allowing the brake shoe (40) to again come into contact with the drum (39), and stopping the rotation of the paper roll before the snubber arm (43) reaches its bottom position where the spring (44) would no longer put tension into the paper.

(3) The paper is fed through the lower guides (46) and over the rollers (47). At the printing position it is held in tension approximately tangent to the type wheel. After leaving the upper guide (48), it passes over the paper feed roller (49) and under the pressure rollers (50), which are held in contact with the feed roller by the springs (51) acting through the levers (52). Two hand levers (53) are provided for lifting the pressure rollers off the feed roller when inserting paper.

(4) The line feed function is accomplished by rotation of the paper feed roller (49). The line feeding mechanism is located on the left side of the printer. The line feed clutch shaft (54) is geared to the type wheel shaft and rotates at 960 rpm. The six-stop line feed clutch (55) is mounted on the shaft. Upon receiving a line feed pulse from the Control Unit, the line feed magnet (56) is momentarily energized, attracting the armature (57) which pulls the clutch trip lever (58) from engagement with the clutch stop arm. The clutch then rotates through one-sixth of a revolution. By this time the magnet has released the armature, and in turn the trip lever, which causes the clutch to disengage and come to a stop, where it is held by the latch lever (59) until receipt of the next line feed pulse.

(5) Each one-sixth revolution of the line feed clutch causes its attached gear (60) to rotate the line feed eccentric gear (61) and its attached eccentrics (62) one-half revolution. The eccentrics, which are offset in opposite directions, each carry a line feed pawl (63). These pawls, guided by a bell crank (64) alternately engage the feed roller gear (65) attached to the paper feed roller (49), and advance the paper one line for each one-half turn of the eccentrics.

(6) Double spaced line feed is normally accomplished by delivery of two line feed pulses from the Control Unit to the line feed magnet (56), and thus takes twice as long as a single line feed. It may be used at all receiving speeds up to andincluding 250 wpm. At 750 wpm, its use could result in the printing of the next following character as much as a full line above its proper position.

FIGURE 2-5

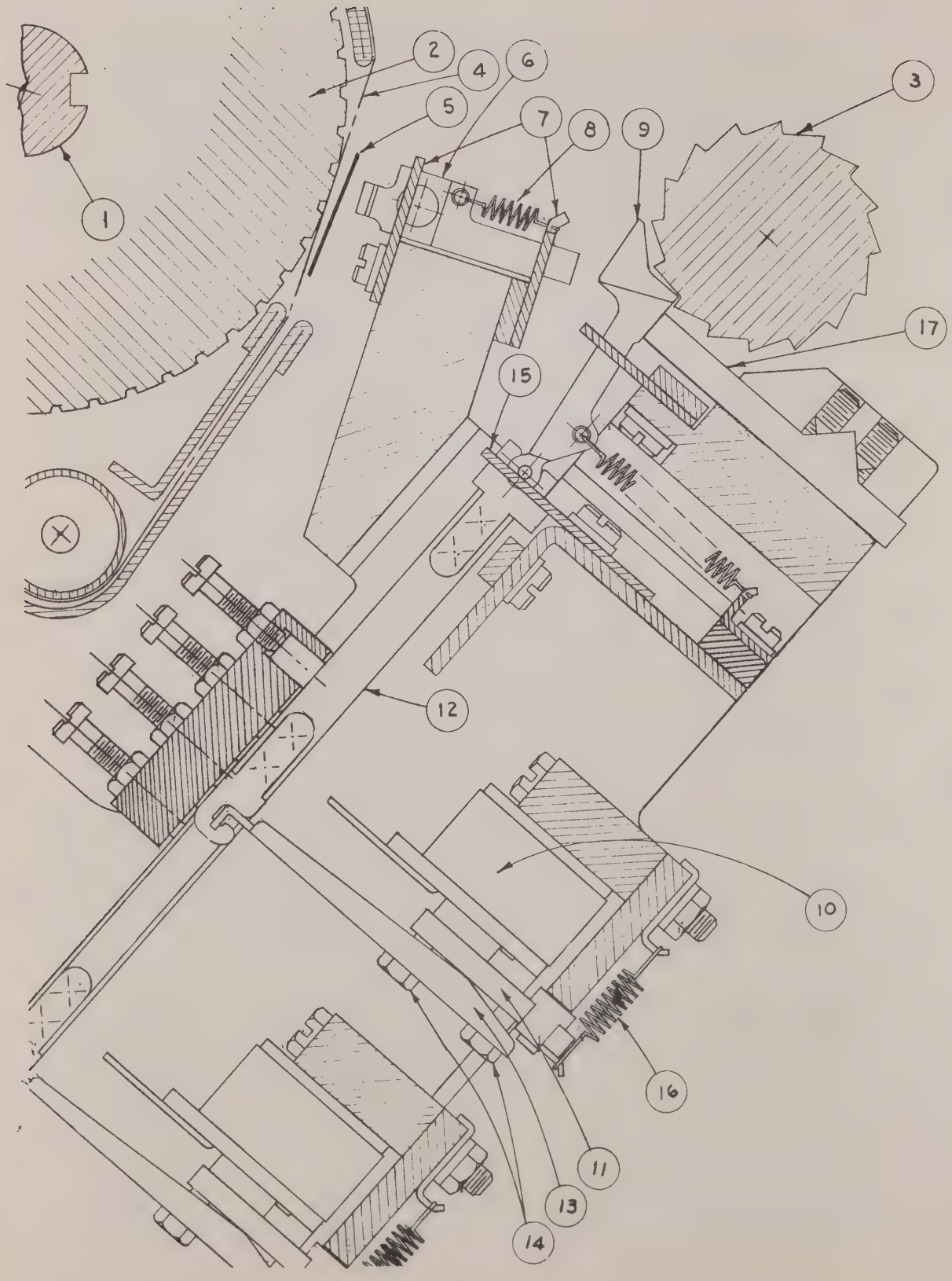


FIGURE 2-6

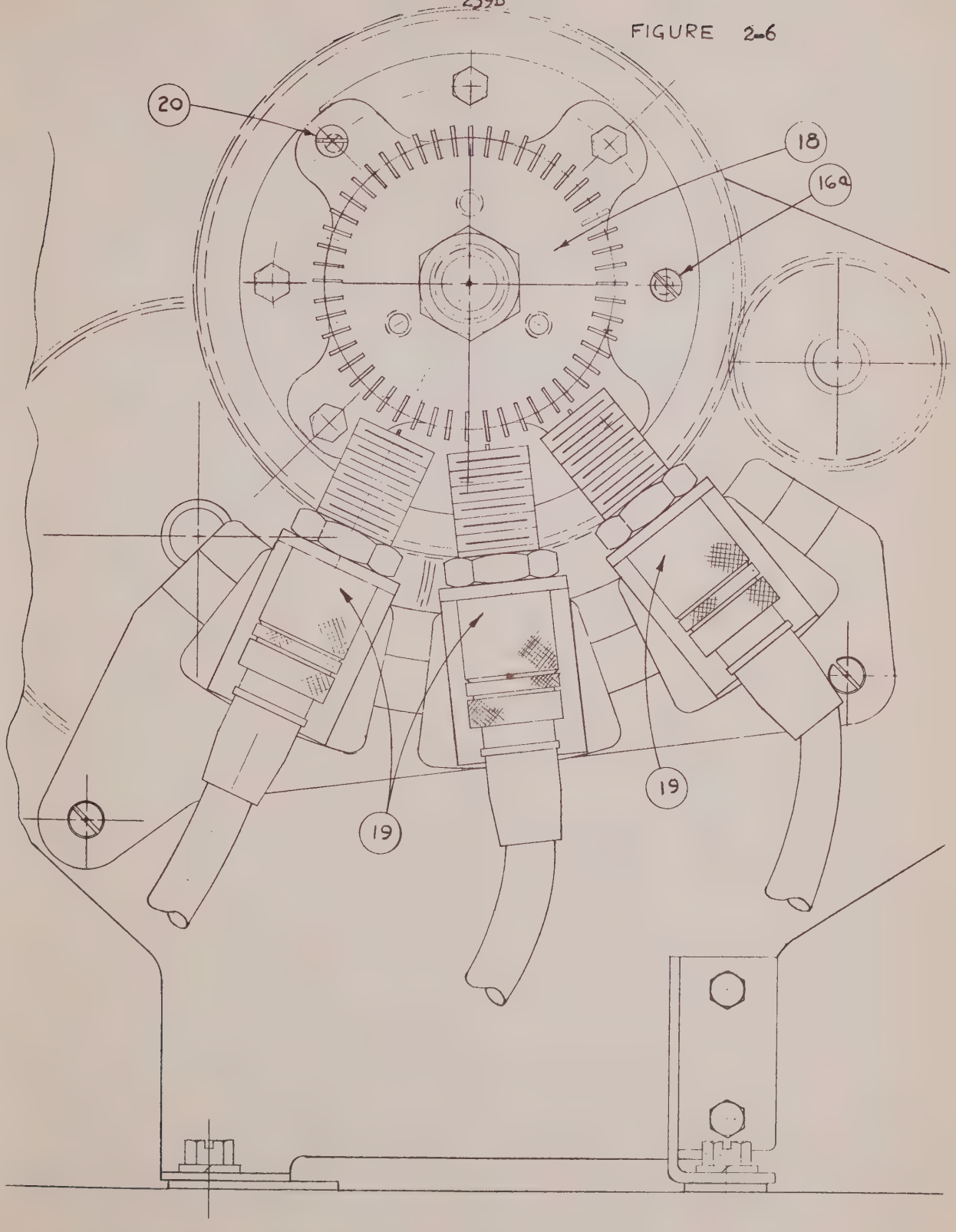


FIGURE 2-7

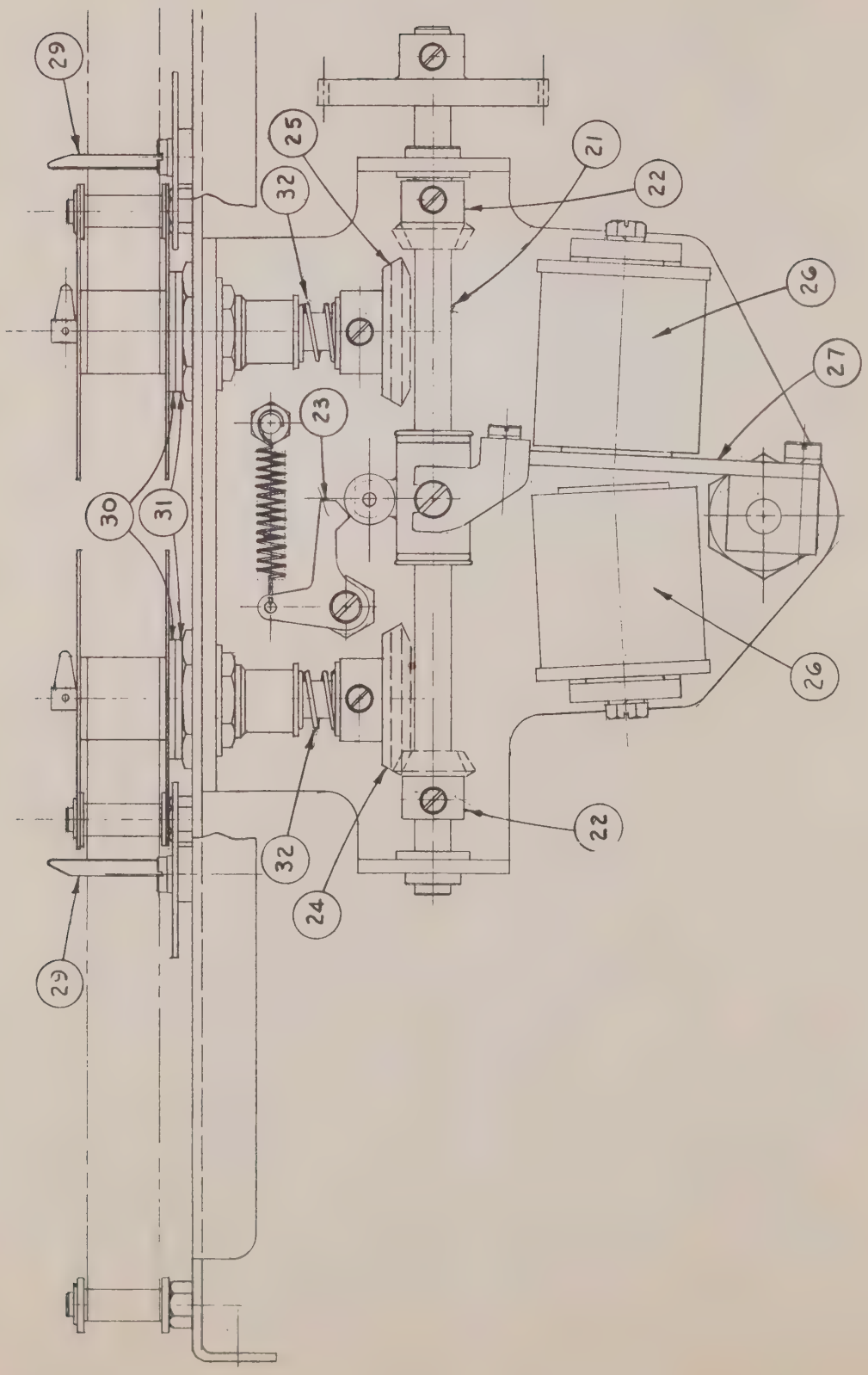


FIGURE 2-8

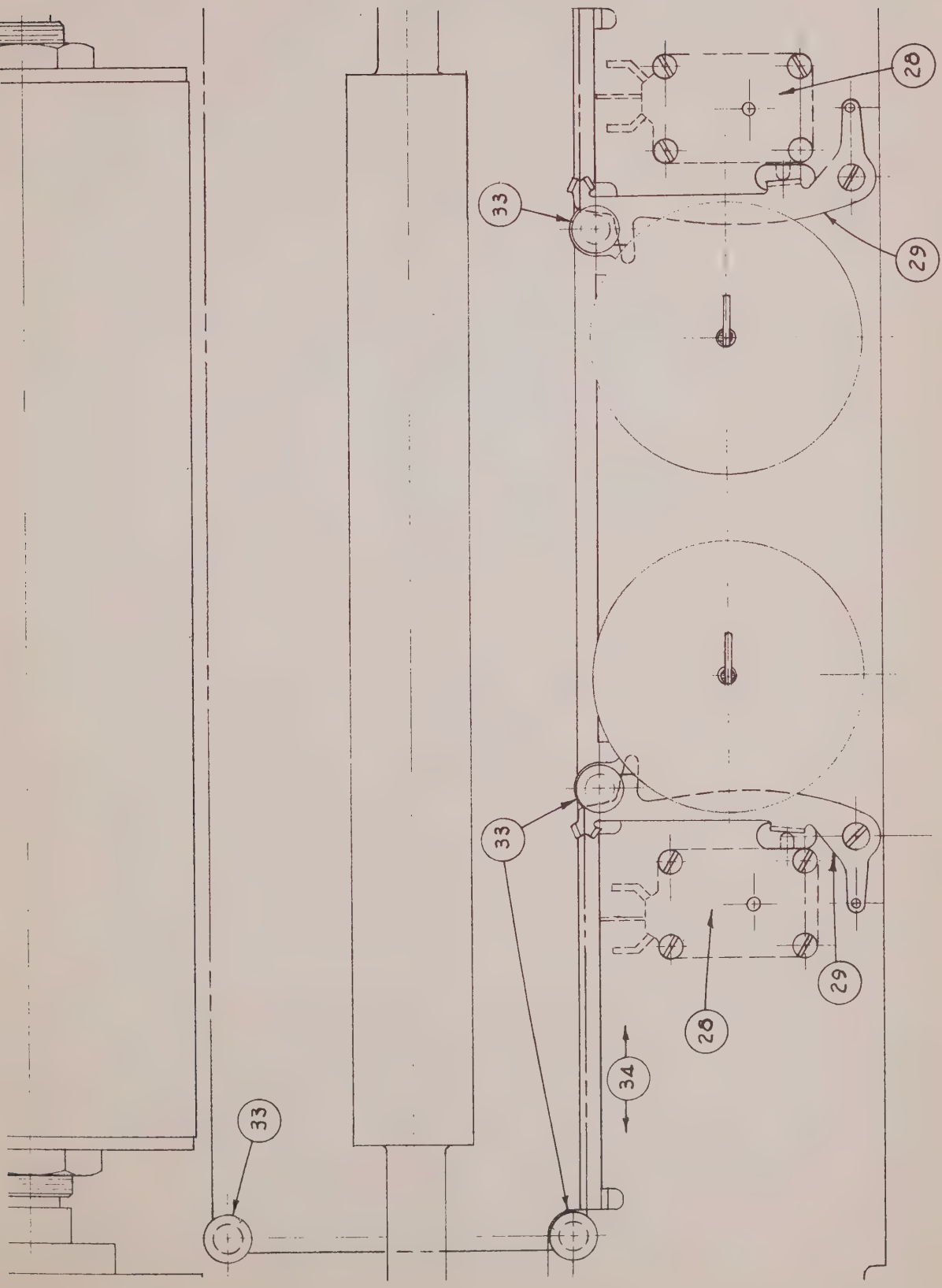
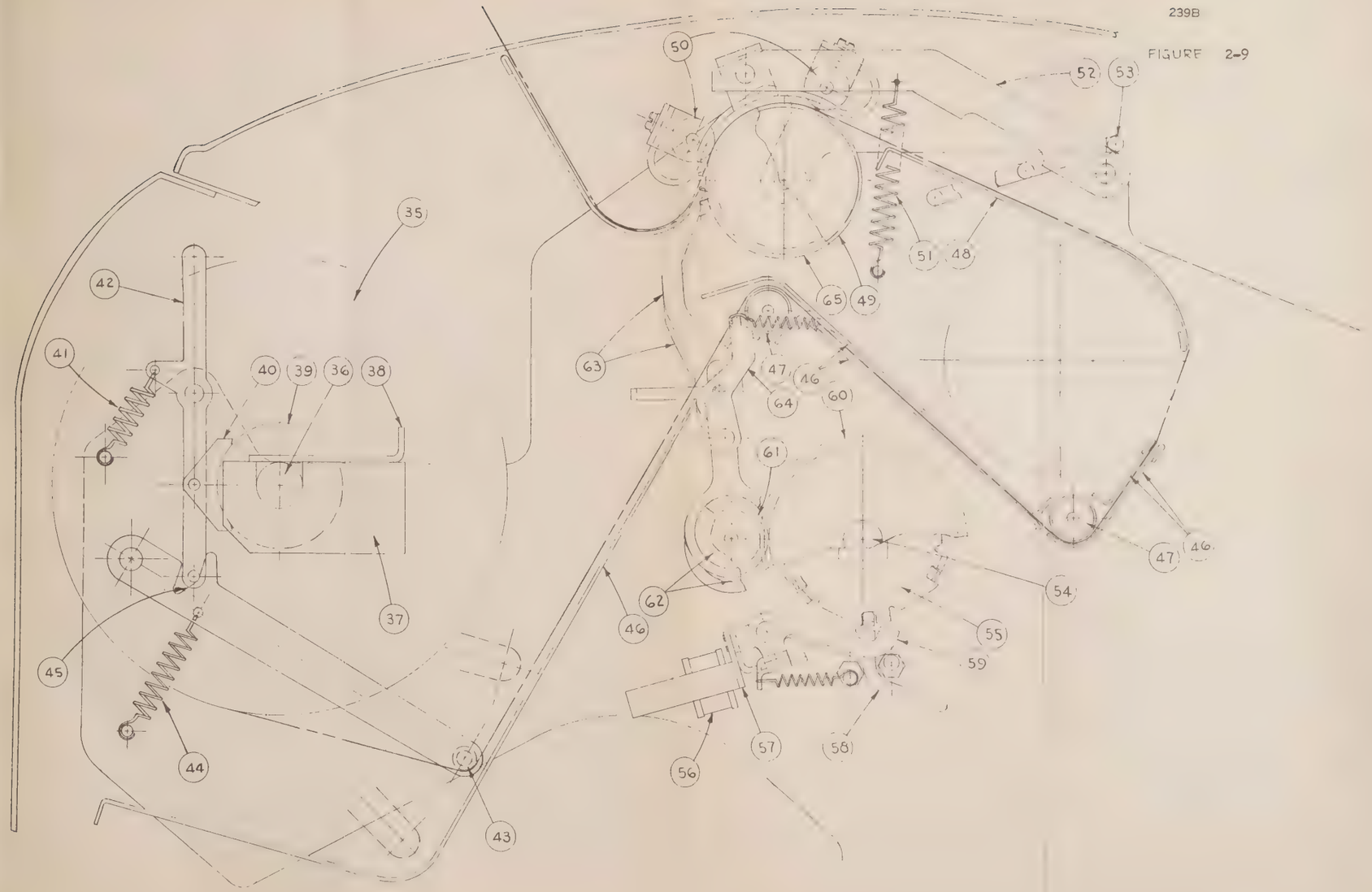


FIGURE 2-9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D. PRINTER CABINET

1. DESCRIPTION

a. The High Speed Page Printer floor mounted cabinet is 38-1/2" high, 20-1/2" wide, 18-5/16" deep, and weighs approximately 80 pounds.

b. The cover lid (dome) of the cabinet may be opened, and is held open in any position by a counter balance. The dome is latched in the closed position, and is opened by pushing the button on the lower right side, then using the copyholder tray as a handle. The cabinet lid is sealed by compressing a sponge rubber strip to minimize the noise of the printer.

c. The rear edge of the window in the dome serves as a tearing off edge for the copy paper. Two incandescent lamps are mounted inside the cabinet and are used for copy illumination and glare reduction.

d. The copyholder tray, is attached to the front surface of the cover lid and is marked with the "TELETYPE" designation.

e. The associated printer (Typing Unit and Keyboard or Receiving-Only Base) is mounted to a cradle which tilts forward and latches for servicing. The cradle is mounted to resilient mounts located in each of the four corners of the cabinet. A signal bell is mounted beneath the floor of the printer compartment.

f. The main power switch is mounted on the left front side of the cabinet, below the keyboard housing.

g. A terminal block is mounted to the left side of the cradle. To this block are made connections to the main power switch, the signal bell and the ribbon reverse mechanism of the typing unit. Insulating strips above and below the terminal block provide protection from shock to operating and maintenance personnel.

h. Four threaded levelling feet are provided which permit the cabinet to be moved about. These may be adjusted to compensate for irregularities in the floor where a cabinet is located, or to provide for up to one inch increase in cabinet height. Thus, more leg room for operators may be supplied.

2. THEORY OF OPERATION

a. Since the cabinet and its accessories utilize only simple passive mechanisms, no special description of theory of operation is required.

E. ELECTRONIC CONTROL SYSTEM

1. Theory of Operation

a. General Functional Description

(1) Transmitting Units

(a) Transmitting Distributor

1. The Transmitting Distributor Unit cooperates with the Keyboard Unit to transmit a start-stop signal at speeds of 60, 66, 75 and 100 wpm. As shown in Figure 2-10, the keyboard delivers the following pulses to the transmitting distributor: combinations of five parallel code pulses, a storage release pulse, start-control pulse, repeat pulse, and signal line break pulse. The latter two are special features and are not used for normal Keyboard operation.

2. As shown in Figure 2-11, Block Diagram of the Transmitting Distributor, the five code pulses are fed to the five storage elements in the distributor. The function of the Storage Release pulse is to clear the previously transmitted character out of storage. This pulse therefore, precedes the code pulses. The start control pulse triggers circuits which unclamp a start-stop oscillator, allowing the oscillator to drive a seven element distributor ring (five code element, a start element, and a stop element).

3. The output of the five code elements are compared in five Gate circuits with the output of the five Storage elements. Each Gate will have a marking output when the associated distributor element is "on" if a marking condition is stored in the corresponding storage element. The output of all the gates are mixed together and fed to the relay control circuits. At speeds of 60, 66, 75 and 100 wpm the Start-Stop Signal is taken from a mechanical Output Relay. At higher speeds (250 and 750 wpm), such as would be used if the distributor were connected to a high speed reader, the relay is not fast enough, and the signal is taken from a transistor relay.

4. The pulse from the repeat key goes to the repeat circuits and causes the last character transmitted to be repeated as long as the repeat key is depressed. The break key causes a continuous spacing potential to appear at the inputs to the relay control and output amplifier circuits.

(2) Receiving Units

The receiving portion of the system consists of six drawers of transistor circuits (Receiving Distributor Unit, Control Unit, three Storage and Character Recognition Units, and a Binary Counter Unit) and three drawers of thyratron circuits. Figure 2-12 is a functional block diagram of all receiving units.

(a) Receiving Distributor

The Receiving Distributor Unit accepts the serial Start-Stop Signal and performs a serial to parallel conversion, putting out combinations of five parallel code pulses plus the stop pulse. Figure 2-13 is a functional block diagram of the Receiving Distributor Unit. Operation is just the reverse of the Transmitting Distributor Unit. Code pulses are delivered to the three Storage and Character Recognition Units (A, B, and C) and also to the Control Unit. The stop pulse also goes to the Control Unit.

(b) Storage and Character Recognition

1. The A, B, and C Storage and Character Recognition Units, shown in Fig. 2-14, are identical and consist of six storage elements, character recognition circuits, and a 25 element switching Distributor ring. (26th element present but not connected.)
2. Switching distributor blocks in Fig. 2-14 are numbered in accordance with the "A" unit. The numbers refer to printing positions with which the "A" unit is associated. "B" unit would have numbers 2, 5, 8, 11, etc. and "C" unit would have numbers 3, 6, 9, 12, etc. The general function of the unit is to accept the parallel code combination from the Receiving Distributor unit, recognize the character and deliver a firing pulse to the proper thyratron print circuit. The firing pulse is called a character recognition pulse.

3. Individual switching distributor drive and transfer pulses are delivered from the Control unit to the A, B, and C Storage and Character Recognition units. The transfer pulse actually puts the character into storage, and the switching distributor drive pulse, in driving the switching distributor, sets up the proper Thyratron Print Circuit to receive the character recognition pulse.

(c) Control

1. The Control unit, shown in block diagram in Fig. 2-15, determines which of the Storage units, A, B, or C, is to receive the code pulses from the Receiving Distributor. For example, the first character in a line of print is directed to "A" unit, the second to "B" unit, and the third to "C" unit. Before the fourth character is received, the first character is printed, and "A" Storage is clear; therefore, the fourth character is sent to "A" Storage. All action in the control unit is begun by the receipt of the stop pulse from the Receiving Distributor.

2. In addition, the control unit recognizes and initiates the carrying out of the various functions, i.e., Letters, Figures, Carriage Return, Space, Blank, Line Feed, Motor Stop, and Signal Bell. Other functions include optional double line feed and automatic carriage return-line feed. Letters-Figures shift is accomplished by adding a sixth pulse to every character following the receipt of the Figures combination. This sixth pulse goes to No. 6 Storage element in the A, B, and C Storage units, and in effect changes the signal from a 5 unit code to a 6 unit code.

3. All functions, except Space, must inhibit printing and spacing and, therefore, connect to the stop pulse inhibit circuit. This prevents the code combinations from being put into storage and also prevents the switching distributor from being pulsed.

Space function circuit is shown connected only to the transfer pulse inhibit circuit and only prevents the code combination from being stored. The switching distributor drive pulse is not inhibited. This provides a space in the line of type but no printing action.

(d) Binary Counter

The function of the Binary Counter unit, shown in Fig. 2-16, is to inform the Storage and Character Recognition unit as to which character on the type wheel is in printing position. Index pulses, from index wheels on the type wheel shaft, drive the six stage Binary counter. In one revolution of the type wheels, 63 index pulses are generated; 52 pulses for the 52 characters on the type wheel, 10 pulses for non-printing characters (functions) for which there are no spaces on the type wheel, and 1 pulse for setting the counter back to zero. The characters on the type wheel are arranged in such a manner that their code combinations are in the order of their binary count. Fig. 2-17 shows the characters, their code combinations, and their sequential order. Therefore, in one revolution of the type wheel, the Binary Counter is set up in the code combination of each character on the typewheel as that character reaches the printing position. The outputs from the Binary Counter go to the character recognition circuits of the three Storage and Character Recognition units. When the code combination in Storage matches the code combination from the Binary Counter, the character recognition circuits generate a pulse that fires the Thyratron print circuit.

(e) Thyratron Print Circuits

1. This section is comprised of three units, A, B, and C, each unit consisting of 25 thyratron printing circuits. The 25 thyratrons in the "A" unit energize selector magnets 1, 4, 7, etc. to 73; the 25 thyratrons in "B" unit 2, 5, 8, etc. to 74; the 25 thyratrons in "C" unit 3, 6, 9, etc. to 75. Character Recognition pulses from the "A" Storage and Character Recognition unit go to all 25 thyratrons in the "A" Thyratron Print Circuit unit. The Thyratron which is to be fired by the pulse is selected by the Switching Distributor in the "A" Storage and Character Recognition unit. The same operation applies to the "B" and "C" units. (Sockets and components are provided for a 26th thyratron, if needed /later.)
2. In addition to the print circuits, "B" Thyratron unit employs a thyratron circuit for Signal Bell function, and "C" Thyratron unit uses two thyratron circuits for Line Feed function.

(3) Units Common to Transmit and Receive

(a) Power Supply

1 This unit supplies all the necessary high and low operating voltages for the electronic control system and other units of the printer set. It is an unregulated, multiple voltage supply, consisting of power transformers, germanium full wave rectifiers and filters.

2 Located on the front panel is a special double range voltmeter for metering all DC output voltages and a milliammeter used for monitoring DC line currents. Fuses, individual voltage adjustments, and a tap changing switch and red-line AC voltmeter are located on the sub-panel.

b. Typical Basic Circuits

This section covers the basic circuits with which all units are built. The theory of operation of the circuits and their applications will be described. Component designations used do not necessarily match those in the equipment. Voltage levels shown are approximate and will vary with tolerance of resistors and quality (leakage characteristics) of transistors.

(1) Flip-Flop (Figure 2-18)

(a) This is a transistor version of the well known cathode-coupled bi-stable multivibrator. Two PNP junction transistors, 2N64, are used. The normal state of the circuit is with Q101 conducting and Q102 cut off. With Q101 conducting, the potential of both emitters is held at -6 volts, while the collector of Q101 is at -7 volts. Thus, approximately 15 volts are dropped across R103. Voltage divider network R106 and R107, connecting the collector of Q101 to the base of Q102, provides a base potential of -3.5 volts at Q102. This is sufficient to hold Q102 cut off, since the common emitter potential is -6 volts. The collector of Q102 then is at approximately -17 volts, which, when coupled back via voltage divider R101 and R102 to the base of Q101, keeps Q101 conducting.

(b) A positive drive pulse, thru C101, of sufficient amplitude to raise the base potential above the emitter potential of Q101 will cut off Q101. As the collector of Q101 drops toward -17 volts, it drives the base of Q102 more negative thru R106. C102 effectively bypasses R106 during this initial phase, accelerating the action. Q102 then begins to conduct, with its collector potential rising toward -7 volts. The regenerative feed back from the collector of Q102 thru R101 reinforces the original drive pulse and the circuit is triggered. Also aiding in the trigger action is the common emitter resistor R105. As Q101 begins to cut off, the emitter becomes less negative which helps drive Q102 conducting. The short narrow pulse on the emitter is indicative of the switching time. To reset the circuit a positive drive pulse is impressed on the base of Q102 through C103, and the opposite triggering action results.

(c) CR101 and CR102 are diodes which prevent negative pulses from getting through to the bases. This is necessary because the negative pulse resulting from a differentiated square pulse, may inadvertently reset the flip-flop.

(d) Applications

In all cases, the flip-flop circuit is used to store information for a period of time. The Transmitting and Receiving Distributors and the Storage units use flip-flops to store code pulses. In the control unit a flip flop is used to store the fact that Figures combination has been received and then adds a sixth pulse to every character following. When Letters combination is received the flip-flop is set back to its normal state.

(2) Start-Stop Oscillator and Control Circuits (Figure 2-19)

(a) The Oscillator is of the negative resistance type with an LC tank, composed of C101 and L101, connected to the base of an F51140 point contact transistor, Q104. Fig. 2-20 shows a typical negative resistance characteristic of a point contact transistor. The D.C. resistance of L101 is such that the base operating point would lie on the negative resistance portion of the base characteristic; but, since this is an unstable region, the circuit oscillates. The load line, A, for this resistance is shown in Fig. 2-19. In the oscillating condition, the resonant impedance of the tank is much higher than the D.C. resistance and is represented by load line B in Fig. 2-19. The circuit oscillates along load line B passing from stable Region I, thru negative resistance Region II, to stable Region III, and back again. The oscillation of the tank carries the operation thru these regions (from points a to b), and maintaining energy is supplied when the negative resistance region is traversed. The output swings from -6 volts to +5 volts.

(b) In the stopped condition, Q103 conducts from the +3 volt supply and thru potentiometer R107, causing a 1 volt drop across L101. This +1 volt on the base of Q104 moves the operating point out of the negative resistance region to point c as shown in Fig. 2-19. In order to start the oscillator, Q103 must be cut off.

(c) Q101, Q102, and Q103 are control circuits used to start and stop the oscillator. All three transistors conduct in order to stop the oscillator. To start the oscillator, the three are cut off. The input to the control circuits is the junction of R101 and R102 in the base circuit of Q101, an NPN common emitter amplifier. To start the oscillator the input to Q101 is -17 volts which cuts off Q101, causing the collector to rise to nearly +12 volts. This positive potential is applied to the base of Q102, a common collector amplifier whose emitter also approaches +12 volts. Q103 then is cut off by this +12 volts potential on its base, and, as previously explained, the oscillator is unclamped. The oscillations always start in the negative direction because of the polarity of the initial charge on C101 and the direction of the energy stored in the field of L101. To stop the oscillator the input to Q101 is raised to -7 volts so that the opposite action occurs, with Q103 clamping the circuit with the +1 volt potential at the base of Q104.

(d) Potentiometer R107 is used to adjust the clamping potential across L101 and also determines the amplitude of the first cycles of oscillation. It is adjusted so that the amplitudes of all cycles are equal.

(e) Applications

The start-stop oscillator is used in the Transmitting Distributor unit to time off the Start and five code pulses for transmission. In the Receiving Distributor unit the start-stop oscillator is used to time off selection pulses.

(3) Distributor Ring (Figure 2-21)

(a) Fig. 2-21 shows a 3 element distributor ring. Each element consists of an F51140 PNP point contact transistor in which the negative resistance characteristic of the emitter is used to provide a bi-stable circuit, i.e., the transistor is either conducting or non-conducting. In the distributor ring one of the elements must always be conducting. Assume that Q101 is conducting before the distributor drive pulses begin. The collector of Q101 is -7 volts, the base is -6 volts, and the emitter is -6 volts. The collectors, bases, and emitters of Q102 and Q103 are -20, -1, and -6 respectively. It is the common emitter potential developed across R107 that holds Q102 and Q103 off. The approximately -1 volt on the bases is the result of transistor leakage in the cut off condition (I_{CO}). C102 has a charge of approximately 5 volts, of the polarity shown, when Q101 is conducting.

(b) The distributor drive pulse is a negative pulse approximately 10 microseconds in duration. This pulse is applied to the emitters of all three transistors, momentarily cutting off any that may be conducting, in this case, Q101. The collector potential of Q101 swings to -20 volts, and C102 immediately begins to charge thru R103 and R102. This causes a negative "spike" with an exponential decay to appear across R103. The rate of decay depends upon the time constant of C102, R102, and R103. When the 10 microsecond drive pulse is over, C102 is still charging, and the negative potential on the base of Q102 is sufficient to render Q102 conducting. The collector of Q102 instantly swings from -20 volts to -7 volts. The next distributor drive pulse turns Q102 "off" and Q103 "on." The third distributor drive pulse turns Q103 "off" and Q101 "on," etc. (The distributor is a closed ring so that the last transistor prepares the first one for conduction.)

(c) Applications

1. In the Transmitting Distributor unit, a 7-element ring (Start element, 5 code elements, and a Stop element) is used to make the parallel to serial conversion of the 5 code pulses and to add the Start and Stop pulses. The distributor ring is driven with pulses derived from the output of the start-stop oscillator.

2. An identical 7-element ring is used in the Receiving Distributor unit. The function of the ring is to pick out the Code pulses in the serial start-stop signal and put them into parallel storage elements. A start-stop oscillator controls the generation of the distributor drive pulses.

3. A 3-element ring in the Control unit directs characters from the Receiving Distributor unit to the A, B, or C Storage and Character Recognition unit. Drive pulses come from the stop element in the Receiving Distributor.

4. A 25-element distributor ring is used in each of the A, B, and C Storage and Character Recognition units. The function of the rings is to direct a selected character to the correct printing circuit. Drive pulses come from the 3-element ring in the Control unit.

(4) Ringing Circuit and Pulse Amplifier (Figure 2-22)

(a) C101 and L101 form a series resonant ringing circuit which has a frequency of approximately 50 kc. Initially, C101 is charged to approximately -20 volts in the polarity shown. When a positive going 17 volt square pulse is applied, C101 discharges its energy into L101 to begin the oscillatory action. CR101, however, prevents the oscillation from continuing past the first half cycle by grounding the energy which L101 tries to deliver back to C101. The result is a positive pulse approximately 10 microseconds in duration, which is fed to common emitter amplifier Q101. The output of the latter is a negative 10 microsecond pulse 12 volts in amplitude.

(b) Applications

These sharp output pulses of the pulse amplifier are used to drive the distributor rings described in paragraph b; (3)

(5) Diode Gate Circuits (Figure 2-23)

(a) A diode gate is a network of diodes which has several inputs and one output. Depending on the type of gate, an output is desired only when the right combination of input potentials exists. For example, an AND gate biased to a -17 volt level must have all inputs at -7 volts in order for the output to be -7 volts. An OR gate will have an output of -7 volts when any of the inputs are raised to -7 volts. Fig. 2-23 shows an AND gate with two inputs (A and B) and one output and an OR gate with two inputs (C and D) and one output. Generally, the inputs come from the collector of a transistor.

(b) AND Gate

With no inputs to the AND gate, i.e., with neither of the input transistors conducting, output of the gate is -17 volts. The -17 volts is due to the current flow from ground, thru R103, and thence thru the parallel input legs CR101, R101 and CR102, R102 to the -22 volt supply. Because of the low forward resistance of the diodes the network is a simple voltage divider, and the output of the gate assumes the potential of the input. Even if input A rises to -7 volts, by virtue of Q101 conducting, the output of the gate will still be -17 volts, because of the current path thru R103, CR102, and R102. Both inputs, A and B, must swing to -7 volts in order for the output to be -7 volts. If input A goes to -7 volts and input B to -8 volts the output will be -8 volts.

(c) OR Gate

The OR gate is similar to the AND gate except the diodes are reversed and the output resistor R106 goes to -22 volts instead of to ground. The output of an OR gate will assume the potential of the least negative input. If either transistor Q103 or Q104 conducts, some of the collector current goes thru the low forward resistance of the diodes and thru R106 to the -22 volt battery. The output, therefore, will be -7 volts when either input, C OR B, is -7 volts.

(d) Applications

These circuits are used throughout the system for producing desired pulses when certain input conditions are met. Some of the applications are: function recognition, selection gates and character recognition. Many more uses will be encountered when the schematic diagrams of the various units are described.

(6) Univibrator (Figure 2-24)

(a) This circuit is similar to the flip-flop circuit previously described, except that the feed back network from the collector of Q102 to the base of Q101 includes a series capacitor, C102. The net result is that there is only one stable state, with Q101 conducting and Q102 cut off. In this state the collector of Q102 is -17 volts and the base of Q101 is -6 volts, causing an 11 volt charge on C102 in the polarity shown. The collector of Q101 is at -7 volts, which, when fed to the base of Q102 via voltage divider R105 and R106, holds the base of Q102 at about -3 volts. The common emitter potential is -6 volts as determined by the conduction of Q101.

(b) Upon receipt of a positive going trigger pulse thru C101 and CR101, the base of Q101 is driven in the positive direction. This tends to decrease the conduction of Q101 and causes its collector to swing in the negative direction, which feeds a negative swing to the base of Q102. Q102 begins to conduct and its collector potential swings in the positive direction. This causes C102 to discharge thru R102 and R101, driving the base of Q101 in the positive direction, reinforcing the initial positive triggering pulse. Also aiding in the action is the common emitter resistor R107 which provides a positive rise in emitter potentials as Q101 stops conducting. This rise helps cause Q102 to conduct. The net result of the regenerative action is that the circuit switches very rapidly, with the potential resulting from the discharge of C102 holding Q101 well cut off and with Q102 completely conducting. The circuit will remain in this quasi-stable state until C102 has discharged to the point where the base potential of Q101 again allows Q101 to conduct, as determined by the time constant of C102, R102, and R101. At this time the circuit triggers back, of its own accord, to the normal stable state. The action is the reverse of the initial triggering, with C102 being charged rapidly thru the emitter-base circuit (effectively a diode) of Q101 and R102.

(c) Applications

The univibrator is used to introduce a delay, time off a period, or produce of pulse of a desired width. An example of a delay is the range circuit in the Receiving Distributor. The stop pulse timer circuit in the Transmitting Distributor is an example of the second application. An example of the third is the selection pip generator in the Receiving Distributor.

c. Theory of Operation of Units

(1) Transmitting Distributor Unit

(a) Schematic wiring diagram Fig. 5-5 shows circuits of the Transmitting Distributor unit and also those circuits of the Keyboard which are pertinent to the description. Timing Diagram, Fig. 2-25, shows the operating sequence of the various circuits. The general description of the Transmitting Distributor was covered in block diagram form in paragraph 2;a;(1).

(b) Idle Conditions - for reference purposes

1. Storage elements - set up in code for last character transmitted.

2. Start control - reset and waiting for next start control pulse from Keyboard.

3. Start-Stop Oscillator - stopped.

4. Start-Stop Distributor - stop element "on".

5. Output OR gate - putting out steady marking signal to relay circuit.

6. Output Signal - steady "mark".

(c) Storage Elements - Q305 thru Q314

The storage elements are five flip-flop circuits. For a mark, the right side conducts and left side is cut off. For a space, the right side is cut off, and the left side conducts. When a character key on the Keyboard is depressed, the storage release contacts deliver a 10 volt positive storage release pulse to the base of the right transistors of all five storage elements (Q306, Q308, etc.) in order to clear the last character out of storage. Code pulses (10 volts positive) in the combination for the character to be transmitted are then applied to the bases of the left transistors (Q305, Q307, etc.), and the character is set up in storage. The output from the storage elements are taken from the right transistor of the flip-flops (Q306, Q308, etc.). For a mark, the output is -7 volts and for a space is -17 volts. These outputs go to the pulse AND gates and await the operation of the start-stop distributor.

(d) Start Control and Oscillator Control Circuits, Q301, Q302, Q330, Q331 and Q332

The start control circuit is another flip-flop whose left side is normally conducting and whose right side is normally cut off. The function of this circuit is to start the start-stop oscillator. The start control pulse from the Keyboard is a positive 10 volt pulse applied thru C301 to the base of Q301. The other input to this base thru C302 is for the repeat function and will be covered later. When the start control flip-flop is triggered, the collector of Q301 swings to -17 volts. This output goes to the stop pulse timer gate which is an OR gate for -7 volts (an AND gate for -17 volts). The function of the stop pulse timer gate will be covered later. The other input to the gate is normally -17 volts so the output becomes -17 volts. This potential is fed to the start control gate, whose function is to start the oscillator. The output of the latter gate is -17 volts when either input is -17 volts, and this is fed to Q330 in the oscillator control circuit. As previously covered, in paragraph 2;b;(2), the oscillator will run when the input to the control circuits (Q330, Q331, Q332) is -17 volts.

(e) Start-Stop Oscillator and Distributor Drive Pulse Circuits, Q333 to Q337.

1. The output of the oscillator, Q333, is a sine wave which swings from -6 to +5 volts as described earlier. Waveform No. 8 in the timing diagram shows the oscillator output. The period of one cycle corresponds to the duration of one pulse in the start-stop signal, e.g., at 60 wpm the period of one cycle is 22.0 milliseconds. The wpm speed is changed by S301 which switches in the correct combinations of L and C. The variable inductors L302 and L303 provide fine adjustment of frequency. The oscillator signal is delivered thru R399 to the base of Q334. Q334, Q335, and Q336 are all common emitter amplifiers which are used to change the sine wave output of the oscillator into a square wave with a 180° phase reversal.

2. The output of Q336 is fed to the ringing circuit C337 and L301. This circuit was described previously in paragraph 2;b;(4). The output of the drive pulse amplifier, Q337, is a series of 10 microsecond negative spikes approximately 12 volts in amplitude. These pulses, waveform No. 9 in the timing diagram, are used to drive the start-stop distributor.

(f) Start-Stop Distributor, Q320, and Q326, and Pulse AND Gates

1. The basic operating principles of distributor rings were presented in paragraph 2;b;(3). The start-stop distributor is a 7-element ring consisting of a start element, five code elements, and a stop element. In the idle condition, the stop element Q326 is conducting or "on" and the other six elements are "off". The outputs of the distributor are taken from the collectors and are -7 volts for "on" and -17 volts for "off".

2. The first drive pulse turns the stop element (Q326) off and the start element (Q320) on. Note that there is a connection from the collector of the stop element to the start control gate, putting -17 volts into this gate when the stop element goes off. Therefore, the oscillator will run as long as the stop element is putting out -17 volts. The collector of Q326 is also connected thru CR331 to the output of all the pulse AND gates, changing the common output of the gates at R359 from -7 volts (marking) to -17 volts (spacing) and initiating the sending of the "start" pulse. The connection from the collector of No. 5 element, Q325, through CR306 and CR303 to the base of Q302, resets the start control flip-flop, Q301 and Q302.

3. The start element, Q320, stays on, timing off the "start" pulse, until the second distributor drive pulse turns it off and the No. 1 element, Q321, on. At this time, note the connections from the collectors of the distributor elements 1 thru 5 to the pulse AND gates, 1 thru 5. As Q321 and each subsequent distributor element is turned on by the series of drive pulses, waveform Nos. 11, 12, 13, 14, 15, and 16, their outputs, of -7 volts, are gated with the outputs of their respective storage elements, producing a -7 volt output if the storage element is on, or a -17 volt output if the storage element is off. The individual outputs of all the pulse AND gates are gated together by means of an OR gate. The seventh drive pulse turns on the stop element, whose collector swings to -7 volts, sending the marking stop signal thru CR331 and also stopping the oscillator thru the start control gate. The resulting start stop signal, -7 volt marking or -17 volt spacing, is fed to the mixer, Q315, a common emitter amplifier, through R360. The timing diagram shows two start-stop characters being produced, R and Y. For the first, storage elements Nos. 2 and 4 have "marks" stored, and, when distributor elements Nos. 2 and 4 are turned on, -7 volt marking potential appear at the outputs of AND gates 2 and 4.

(g) Output Relay Circuits, Q315 to Q319

1. The collector of Q315 swings from about -12 volts for a mark to +12 volts for a space. Q317 and Q316, spacing and marking controls respectively, are common collector amplifiers. Q316 conducts on a mark and its emitter becomes -12 volts, causing Q318, the marking amplifier to conduct and drive the low speed output relay K301 to its marking contact. Q319 is held cut off by a -12 volt potential at its base, which is the result of the -12 volts applied to the base of Q317 having rendered the latter amplifier non-conducting. The relay operating current path is from ground, thru the relay windings, Q318 and R367, to the -22 volt supply. For a spacing signal, Q319 conducts as a result of +12 volts appearing at its base, and Q318 is cut off. This drives the relay in the opposite direction with current flow from +22 volts thru R368, Q319, the relay windings, and to ground. The potential at the emitters of Q318 and Q319 swings from about -4 volts for a mark to +4 volts for a space. Current in the relay windings is about 10 milliamperes.

2. Operation with low speed output relay K301 requires use of an external battery. If operation with local battery is desired, or for operation at the higher speeds of 250 and 750 wpm, output relay switch S302 should be placed in the HIGH position.. S302 disconnects the start-stop signal line from the contacts of K301 and places the line in series with the high speed transistor output relay Q339. Q339 is connected in the common emitter configuration and receives its collector potential through the external start-stop signal line from the -45 volt

supply. As described in paragraph (g);1; the output of marking control Q316 is +12 volts for a space and -12 volts for a mark. This output is applied through R563 to the base of Q339. When a +12 volt signal is applied to the base of Q339, Q339 will be biased in the reverse direction, cutting off the transistor and causing a high impedance to appear between the collector and emitter to ground. No current will thus flow in the signal line. When a -12 volt mark signal is applied, however, sufficient bias current will flow in the base circuit to cause the transistor to become saturated. Effectively the resistance from collector to emitter will become zero and line current will flow. The start-stop signal current path is from ground, through Q339, R564, the external start-stop circuit, R556, to the -45 volt supply. Potentiometer R564 adjusts the line current.

(h) Keyboard Lock, Q328 and Q329

The purpose of this circuit is to hold the Keyboard inoperative during the transmission of a character, and then to release the Keyboard for the setting up of the next character during the stop time. Q329 is controlled by Q302 of the start-control flip-flop. Q302, normally at -17 volts, has an output of -7 volts from the time that the start-control is triggered on until it is reset by the firing of the N_o. 5 element of the start-stop distributor. The -7 volt potential applied to the base of Q329, a common emitter amplifier, causes conduction so that the collector of Q329 drops to approximately -12 volts. R560 couples this output to the base of Q328, a common emitter amplifier, which is driven into conduction. The current through Q328 energizes the Keyboard latch magnet which is connected in series with the collector circuit of Q328, holding the Keyboard inoperative. When the start-control flip flop is reset, causing the output of Q302 to go to -17 volts, the Keyboard latch magnet is de-energized and the Keyboard is released. This enables the next key to be depressed during the stop pulse. Reader-keyboard switch S303 disconnects Q328 from the magnet circuit during high speed reader operation.

(i) Stop Pulse Timer and Stop Pulse Timer Gate, Q303, and Q304

1. The stop pulse timer is a univibrator circuit used to time off the stop pulse at the various Keyboard transmitting speeds (60, 66, 75, and 100 wpm). The stop pulse for these speeds are 31.2, 28.4, 25, 19.1 milliseconds respectively. S301 switches in different timing capacitors in order to change the operating period for the various speeds. A positive trigger pulse to the base of Q303 is brought in thru CR309 and C306 when the stop element of the distributor turns on. The operating principles of the univibrator circuit were covered in paragraph 2;b;(6). There are two outputs taken from the stop pulse timer.

2. Collector of Q304, which is normally at a potential of -17 volts, is connected to the stop pulse timer gate. This, by definition, is an OR gate whose output will be -7 volts when either input is -7 volts. Recall that in order to start the oscillator this gate had to put out -17 volts. The other input to the gate comes from Q301 of the start control flip-flop. While the stop pulse timer is timing off the stop pulse, the collector of Q304 is at -7 volts. This prevents the stop pulse timer gate from putting out -17 volts, even if the depression of another key triggers the start control flip-flop, causing the other input to the gate to swing to -17 volts. In this case, the gate must wait until the stop pulse timer triggers back to its normal state, at which time it can put out -17 volts and start the oscillator for the sending of the next character.

3. The other output is taken from the collector of Q303, which is normally at -7 volts, and applied to the repeat gate. While the stop pulse timer is timing off the stop pulse, the collector is at -17 volts.

(j) Repeat Gate

1. The function of the repeat gate is to cause the retransmission of the last character sent for as long as the repeat key on the Keyboard is held depressed. The repeat gate is an AND gate which puts out -7 volts only when each input is -7 volts. The two inputs to the gate are from the repeat key on the Keyboard and the collector of Q303. It should be recalled that a character is held in storage until depression of the next character key clears the storage. Now, operation of the repeat key does <u>not</u> clear the storage of the last transmitted character!

2. The repeat key can be depressed at any time. Assume that a character has already been transmitted, and the stop pulse timer is in its normal state with the collector of Q303 putting out -7 volts. The repeat key closes its contact to +12 volts and applies -7 volts, from the junction of R302 and R303, to the other input of the repeat gate, causing the output of the gate to swing from -17 volts to -7 volts. This change is differentiated thru C302 and the resulting positive pulse triggers the start control flip-flop, initiating transmission. When the stop pulse timer is subsequenly triggered, designating the beginning of the stop time, the collector of Q303 swings to -17 volts, and the output of the repeat gate also goes to -17 volts. At the end of the stop time the collector of Q303 goes back to -7 volts, triggering the start control flip-flop again. This action cycle continues as long as the repeat key is held depressed, and the character originally in storage is repeatedly transmitted.

(k) Signal Line Break

The break key on the Keyboard closes a contact wich applies +12 volts to the bases of the marking and spacing control amplifiers Q316 and Q317. As described in paragraph 2;c;(2);(g), this +12 volt potential will drive the output relay K301 to its spacing condition, thereby introducing a continuous spacing "Signal Line Break" on the output line.

(l) Operation with High Speed Tape Reader

For operation at 250 and 750 wpm, a high speed tape reader must be used. The Code pulses and the start control pulse are brought into the Transmitting Distributor in the normal manner.
If a storage release pulse of the proper timing cannot be obtained from the reader, S303 provides a release pulse from the stop element of the distributor.

(3) Receiving Distributor Unit

(a) Schematic wiring diagramFig.5-6shows the circuits of the Receiving Distributor unit. The operating sequence of the circuits are shown in the Timing Diagram, Fig. 2-26. The general description was covered in paragraph 2;a;(2);(a).

(b) Line Relay, Q401 and Q402

1. The start-stop signal enters the line relay circuit of the Receiving Distributor at terminals 1 and 2 of connector J401. The line current passes thru either R401 and R403 for 60 milliampere operation, or thru R402 and R404 for 20 milliampere operation, as selected by input current switch S401. The drop across loop resistor R425 is measured by a voltmeter on the power supply panel as an indication of the line current. The purpose of the line relay is to translate the start-stop signal into useable form, and to isolate the Receiving Distributor circuits from the signal line power source.

2. Approximately +6 volts are developed across R401 by the 60 milliampere line current. Transistor Q401, winding 1-2 of T401, and a tank circuit formed by winding 3-4 of T401 and C401 comprise a tuned-base oscillator circuit. The frequency of oscillation is approximately 68 kilocycles. Oscillation takes place only when a marking signal is received, with the line current providing all the power required. The +6 volts developed across R401 is used as collector potential for Q401. Q402 must also be conducting in order for Q401 to sustain the oscillation. Q402 is controlled by CR401, a Zener diode, whose back resistance breaks down at 3 volts, driving the base of Q402 positive and allowing Q402 to conduct. Thus, oscillation will not start until the voltage across R401 and R402 has built up to +3 volts. R407, the sensitivity control, varies the level at which Q402 is allowed to conduct and, consequently, the point at which the Receiving Distributor recognizes a mark-space or space-mark transition.

3. The output from the line relay circuit is inductively coupled to winding 5-6 of T401. Waveform 2 of Figure 2-26 shows the 68 kilocycle on-off signal as it appears across winding 5-6 of T401.

(c) Rectifier and Signal Shaper, Q403, Q404, Q405

1. Q403 is a common emitter amplifier biased to cut off by collector leakage current, I_{CO}. The collector load is a tank circuit, L401 and C403, broadly tuned to the same frequency as the line relay oscillator. For a spacing condition, the collector is quiescent at approximately -22 volts. When a marking signal appears, the negative half of each 58 kilocycle cycle is amplified by Q403, and the collector tank circuit is pulsed into resonant oscillation. The collector voltage then swings between -13 volts and -29 volts at the 68 kilocycle rate, as long as the excitation exists.

2. This signal is fed thru C404 to CR402 and CR403, positive and negative rectifiers respectively. C405 and C406 are filter capacitors which shunt the 68 kilocycles to ground but preserve the envelope. The output of CR402 is a nearly square-shaped wave (+4 volts marking and -5 volts spacing). The output of CR403 is a similar but inverted wave (-13 volts marking and -5 volts spacing). The average d.c. operating points differ due to the action of the circuits to which the rectifiers deliver power.

3. The rectified signals are fed into the bases of Q404 and Q505 which comprise a signal shaping trigger circuit. For a spacing signal, Q404 is held conducting by the negative

potential applied to its base, thru R410, from the collector of Q405. The base and emitter potential of Q404 are thus both approximately -7 volts. This common emitter potential holds Q405 cut off, because its base is at -4 volts, as determined by voltage divider network R415, R414, CR403, CR402, and R409. A marking signal drives the base of Q404 in the positive direction and the base of Q405 in the negative direction. This triggers the circuit, with the collector of Q404 swinging to -20 volts and collector of Q405 to -8 volts. The trigger action is caused by regenerative coupling from the collector of Q405 to the base of Q404 and between the common emitters.

4. The output from the collector of Q405 is a normal start-stop signal swinging from -8 volts marking to -19 volts spacing. The output from the collector of Q404 is an inverted start-stop signal with -20 volts marking and -7 volts spacing. These signals are shown as waveforms No. 3 and 4 respectively on the timing diagram. The inverted signal is fed thru CR407 and C408 to the range circuit. The normal signal is fed to the hit delete gate and to the selection gate.

(d) Range Circuit, Q406 and Q407, Hit Deleter, and Start Control Gates

1. The range circuit is a univibrator such as was described in paragraph ;2;b;(6). Q406 is normally conducting and Q407 is normally cut off. CR407 passes only the positive signal transitions from Q404 to C408, where they are differentiated into sharp positive impulses which occur at the instant the line signal is making mark to space transitions. The impulses are applied to the base of Q406, cutting Q406 off and triggering the univibrator. The function of the range circuit is to introduce a variable delay after the mark to space transition of the "start" pulse in each received character. As previously explained, the operating period of this type of circuit is determined by the time constant of the RC network in the base circuit of the normally "on" transistor, in this case Q406. S402 selects the proper RC combination for the various speeds. R422 provides a fine adjustment for varying the amount of regenerative feed back and, consequently, the length of the operating period.

2. The output of the range univibrator is taken from the collector of Q407 which is normally at a potential of -17 volts. This potential is applied to the hit delete gate, CR405, CR406, and R418, an AND gate for negative potentials. The other input to the gate is the normal signal from the collector of Q405. The function of the gate is to produce an output (-18 volts) to release the start-stop oscillator only when a bonafide start pulse is received. Assume that the mark to space transition of a start pulse from a 60 wpm

signal has just been received. The collector of Q405 puts -18 volts into the hit delete gate, and the range univibrator is triggered, with the collector of Q407 putting -8 volts into the gate. The gate output is the most positive potential, or -8 volts. Approximately half way thru the start pulse (11 milliseconds), the range univibrator returns to its normal state, and the output from the collector of Q407 swings to -20 volts. The output of the hit delete gate then becomes -18 volts at the proper time for starting the distributor. If the mark to space transition was a momentary hit on the line, instead of a bonafide start pulse, the output of Q405 would have reverted to -8 volts before the output of the range univibrator became -20 volts; and the hit delete gate output would remain at -8 volts, thereby not supplying the negative potential required to start the distributor. CR407, in the input circuit of Q406, blocks the negative pulses generated at the end of short hits which might cause the range control circuit to relax to its unoperated condition at too early a time.

2. The output of the hit delete gate ties directly to the start control gate, CR412, CR413, and R451, an OR gate for negative potentials. This gate is identical to the start control gate in the Transmitting Distributor. In order to start the oscillator the output of this gate must be approximately -17 volts. The other input to the gate comes from the stop element in the start-stop distributor and is -7 volts before the start pulse is received. When the hit delete gate output swings to -18 volts, the start control gate follows suit and puts out -18 volts, starting the oscillator. As soon as the oscillator starts, the stop element in the distributor is turned off; and its output of -17 volts then holds the start control gate at -17 volts for the duration of the distributor cycle. Note in the timing diagram that the oscillator, waveform No. 5, begins oscillating about half way thru the start pulse of the start-stop signal.

(e) Start-Stop Oscillator and Controls, Q408, Q409, Q410, and Q415; Distributor Drive Pulse Circuits, Q411-Q414; and Start-Stop Distributor, Q420-Q426

1. These circuits are identical to those of the Transmitting Distributor, described previously, and will not be covered in detail. The distributor drive pulse circuits take the oscillator output and produce pulses (waveform No. 6) which drive the seven element distributor ring.

2. With no input signal to the line relay, the stop element in the distributor is "on" and the oscillator is not running. Upon receipt of a start pulse, the oscillator is released and the first drive pulse turns the stop element off with

the start element immediately coming on. The seventh drive pulse turns the stop element on again, and the oscillator is stopped. Note, on the timing diagram, that the distributor drive pulses occur in the center of the code pulses and that the code elements of the distributor are thus turned on at these times.

(f) Selection Pip Generator, Q416 and Q417; Selection Gate and Pulse Amplifier, Q418

1. In addition to driving the distributor, the 10 microsecond, -12 volt, drive pulses, derived from Distributor Drive Amplifier Q414, also trigger the selection pip generator, another univibrator circuit. Q417 is normally conducting and Q416 is normally cut off. Each negative drive pulse is fed thru C419 and CR410 to the base of Q416, triggering the circuit. The operating period of the univibrator is very brief (approximately 100 microseconds), as determined by the time constant of C417, R427, and R433. The output from the collector of Q416 is a series of positive going, 100 microsecond pulses, occurring seven times per character and swinging from -17 volts to -7 volts.

2. These pulses are fed to the selection gate which is an AND gate comprised of CR408, CR409, and R426. The other input to the gate is the normal start-stop signal from the collector of Q405. This signal is -8 volts for marking and -19 volts for spacing. The selection gate will produce an output upon coincidence of a marking signal (-8 volts) and a selection pip (-7 volts). The output pulse swings from -19 volts to -8 volts and is approximately the same shape as the selection pulse itself.

3. The selection pulses are fed to the base of Q418, the selection gate pulse amplifier, a common collector amplifier. The emitter of Q418 follows the base and reproduces the pulses. Waveform No. 7 in the timing diagram shows the selection pulses resulting from an RY signal input. Note that they occur in the center of their respective start-stop signal code pulses. Potentiometer, R422, in the range control circuit, described previously, is used to vary the selection pips with respect to the start-stop signal code pulses. Nearly 100 points of range are thus provided by the range control, for testing purposes, and the optimum setting may be chosen for normal operation.

(g) Storage Selection Gates

1. There are five storage selection gates, one for each code pulse in the start-stop signal. The gates are AND gates, each with two inputs. One of the inputs is the series of 100 microsecond selection pulses just described, and the

other is the output of the respective distributor element. The storage selection gates put out pulses only when the turning on of their respective distributor elements coincides with the corresponding marking code pulse in the input start-stop signal.

2. The center of the gates swing from about -19 volts to -8 volts. However, CR425, CR428, CR431, CR434, and CR437 clamp the final output so as to be no more negative than -15 volts. The purpose of this is to prevent any variation in the gate output that might affect the storage circuit. The result is that each storage coupling capacitor receives a four volt positive going pulse for a marking signal selection. Referring to the No. 2 gate, for example, when receiving a No. 2 marking pulse, C437 differentiates the positive going swing into a sharp positive pulse which is applied to the No. 2 storage element.

(h) Storage Circuits, Q430 to Q439

1. The five storage elements are flip-flop circuits such as were described in paragraph 2;b;(1). The left transistor is normally conducting and the right transistor is normally cut off. Referring again to the No. 2 storage, the positive pulse thru C437 triggers the circuit, cutting off Q431 and driving Q436 into conduction. The collector of Q436 swings from -17 volts to -7 volts, as shown in waveform No. 16 in the timing diagram. A marking pulse is therefore stored in the No. 2 storage circuit. The character R, as shown, also causes a mark to be stored in the No. 4 storage circuit. Note that for character Y, storage elements Nos. 1, 3, and 5 are in the marking condition.

2. After the complete character has been received and the output pulses for that character are delivered to the associated units of the system, the storage circuits must be cleared for the reception of the next character. The storage release amplifier, Q427, a common collector amplifier, accomplishes this at the instant the distributor starts on the next selection cycle. The output of the start element of the distributor, a positive going pulse, which is amplified by Q427, and applied through differentiating capacitors, C441 to C445, to the bases of storage transistors, Q435 to Q439. This causes the triggering of all the operated flip-flops back to the spacing condition, thereby releasing the storage for the incoming characters.

(i) Output of Receiving Distributor and Stop Pulse Amplifier, Q428

1. The outputs of the Receiving Distributor consist of ten code potentials (5 marking and 5 spacing) from the ten collectors of the five storage elements and a pulse from a stop pulse

amplifier, Q428. The latter a common collector amplifier gets its input from Q426, the stop element of the distributor. The output from the emitter of Q428 swings from -17 volts to -7 volts when the stop element turns on. This output is delivered to terminal 11 of J402 and is called the stop pulse.

2. Terminals 1 thru 10 take code potentials from the storage circuit elements. These are -7 volts for marking and -17 volts for spacing on the odd numbered terminals, and the opposite potentials on the even numbered terminals, and are utilized during the stop pulse interval of the distributor.

3. The code pulses go to the three Storage and Character Recognition units (A, B, and C) and to the Control Unit. The stop pulse goes to the Control Unit. These interconnections were shown in Figure 2-12.

(j) Indicator Amplifier, Q429

1. The output of the stop pulse amplifier, Q428, is applied to the indicator amplifier Q429, a type 903 common emitter amplifier. Q429 conducts during the stop interval, causing indicator lamp DS401 to light.

2. The flashing of DS401 indicates the activity of the receiving distributor in accepting signals. A steady glow shows that the distributor is at rest with no signals being received.

(3) Storage and Character Recognition Units (A, B, and C)

Note: As was apparent in the functional description of II;2;a, the operation of the Storage and Character Recognition units depends upon the control unit. Therefore, some of the following descriptions may not be complete until the control unit is covered.

(a) Recall in the General Description that the basic speed of the printing mechanism was approximately 250 wpm and that a speed of 750 wpm was attained by storing three characters and printing three characters in one revolution of the type wheel. The three storage positions are contained in the A, B, and C Storage and Character Recognition units. Schematic wiring diagram, Fig.5-8, and timing diagram, Fig.2-27, will be used to describe the operation. The schematic applies to any one of the three units, since they are identical, except for "C" unit whose 25th printing distributor element puts out a pulse for automatic Carriage Return Line Feed. The timing diagram covers all three units and shows six characters being received and directed to the proper units. Waveform No. 1 in the timing diagram shows a 750 wpm start-stop signal that is being received by the Receiving Distributor. This waveform is for reference only and does not appear within the Storage and Character Recognition units.

(b) Storage Gates

1. Each storage gate has two inputs: a code pulse and a transfer pulse. Code pulses for storage gates Nos. 1 thru 5 come from the Receiving Distributor. The sixth code pulse comes from the control unit and appears for figures only, being turned on upon reception of "Figures" and remaining on until turned off by reception of "Letters". These six code pulses are fed to the storage gates of all three (A, B, and C) units. The transfer pulse comes from the Control Unit, but goes to only one of the three units, A, B, or C.

2. The storage gates, from which the storage elements derive their triggering pulses, are AND gates. Code pulses, -7 volts marking and -17 volts spacing, brought in thru terminals 1 to 6, are fed to their respective gates. Using No. 1 gate as an example, its code pulse comes in to CR802. The other input to all the gates is the transfer pulse, a sharp pulse swinging from -17 volts to -7 volts, received from the Control Unit. This pulse comes in thru terminal 19 of J801, and for the No. 1 gate is applied to CR801. Upon receipt of this pulse, the outputs of those gates whose code pulse inputs are marking (-7 volts) will swing from -17 volts to -7 volts for the duration of the transfer pulse. The output of each gate is applied to its corresponding storage element.

3. Assume that the first character shown in waveform No. 1 of Fig. 2-27 is to be the first character in a line of print. As such, it must be directed to the "A" Storage and Character Recognition Unit. The actual directing is accomplished in the Control Unit. Waveforms Nos. 2 to 6 represent the code pulses from the Receiving Distributor, and No. 7 represents the sixth code pulse which comes from the Control Unit for figures. The transfer pulse, which arrives shortly after the code pulses, for "A" unit is shown in waveform No. 9. Waveforms Nos. 14 and 19 are the transfer pulses for "B" and "C" units respectively. Note that "A" unit gets a transfer pulse for the 1st and 4th characters, etc., "B" unit the 2nd and 5th characters, etc., and "C" unit the 3rd and 6th characters, etc.

(c) Storage Elements, Q801 to Q812

1. The storage elements are flip-flop circuits, of the type previously described, with the left (space) transistor normally conducting and the right (mark) transistor normally cut off. For example, in storage element No. 1 the collector of Q801 is normally at -7 volts and the collector of Q802 is normally at -20 volts, representing a spacing condition. The output of storage gate No. 1 is applied to C801 where it is sharply differentiated. Only the positive pulse is passed by CR803 and applied to the base of Q801. This positive pulse triggers the flip-flop, causing Q801 (space) to cut off and Q802 (mark) to conduct, thus placing the circuit in the marking condition.

2. The mark and space outputs of each storage element are applied to corresponding mark and space buffer amplifiers, Q849 to Q860. These amplifiers are connected in the common collector configuration and serve to reduce loading of the storage elements. In storage element No. 1, for example the collector output of Q801 is applied directly to the base of Q849. The emitter of Q849 exactly reproduces the collector voltage swings of Q801. Similarly, the collector output of Q802 is applied to the base of Q850. The outputs of each mark and space amplifiers swing from -20 to -7 volts and are applied to their corresponding portions of the pulse recognition gates.

(d) Pulse Recognition Gates and Recognition Pulse Amplifiers Q813 to Q818.

1. Once the code combination of a character has been put into storage, it is time to compare that combination with the output of the Binary Counter. This was covered functionally in paragraph 2; a; (2); (d), and it is recommended that paragraph now be revised. Line 23 in the timing diagram shows the characters whose code combinations are fed in from the Binary Counter unit at any time.

2. There are six pulse recognition gates, one for each element in the code combination. Each pulse recognition gate is comprised of two AND gates and one OR gate (for positive swinging potentials) and has four inputs. Two of the inputs come from the emitters of the respective mark and space amplifiers. The other two inputs come from the collectors of the respective stages of the six-stage binary counter circuit in the Binary Counter unit. As described in paragraph 2; b; (7), a binary counting stage is similar to flip-flop, that is, it consists of two transistors in a bi-stable circuit. A pulse recognition gate delivers a -7 volt potential when the condition of its respective storage flip-flop is matched by the respective binary counting stage.

3. For example, refer to pulse recognition gate No. 1 in the schematic diagram. The space AND gate consists of CR825, CR826, and R810; the mark AND gate includes CR829, CR830, and R811; and the OR gate is CR827, CR828, and R809. The outputs of the AND gates comprise the inputs to the OR gate. Assume that storage element No. 1 is in the marking condition, causing the emitter of Q849 to be at -20 volts and the emitter of Q850 to be at -7 volts. In order to match this condition, the first stage of the binary counter must put -20 volts thru terminal 7 of J801 to CR826 of the space gate and -7 volts, thru terminal 8 to CR829 of the mark gate. The mark gate delivers -7 volts to CR828 because both inputs are -7 volts, while CR827 will receive -20 volts from the space gate. The output of the No. 1 pulse recognition gate will be -7 volts, because one of the inputs to the OR gate is -7 volts. Had there been a mismatch between the storage and binary counter, both AND gates and the output of the pulse recognition gate would have remained at -20 volts. Observe that if the No. 1 storage element had been spacing, and if the No. 1 stage of the binary

counter had been reversed, the conditions would have matched also, and the space AND gate would have put out the -7 volts. When the complete code combination (all six code elements) in storage matches the combination put out by the Binary Counter, all pulse recognition gates have an output of -7 volts.

4. Referring to the timing diagram, item 12 shows the periods during which the code combination in the "A" storage can be compared with the code combination from the Binary Counter. Note that this period begins as soon as a character is put into storage by the transfer pulse. During this period the typewheel will make one revolution, and the six-stage binary counter will complete one cycle of counting, being set up in turn in the code combinations of every character on the type wheel. A printing character is set up in the counter every 721 microseconds or 52 times during the period shown.

5. These outputs are fed to the recognition pulse amplifiers, which, as common emitter amplifiers, reproduce the pulses applied to their respective bases. Thier emitters, therefore, put out either -7 or -20 volts, as the case may be.

(e) Character Recognition Gate, CR831, CR838, CR845, CR852, CR859, CR866, CR867, R873.

1. This is an AND gate whose inputs come from the emitter of all the recognition pulse amplifiers. Another input comes in thru terminal 27 of J801 from the character index pulse delay circuit located in the Binary Counter Unit. This input is a series of positive going pulses, each pulse delayed approximately 100 microseconds from the character index pulses which drive the six-stage Binary Counter circuit. This pulse appears at terminal 27 immediately following the instant that the binary counter is stepped to those code combinations which are represented by characters on the typewheel (52 times per typewheel revolution or every 721 microseconds). This pulse insures that the character recognition gate will have an output only at the instant a character code combination is first set up in the binary counter circuit, rather than at any time during which the circuit is in that combination.

2. The gate will have an output only when the -7 volt potentials from all the emitters of the recognition pulse amplifiers are coincident with the relatively narrow (50 microseconds) delayed index pulse. The output pulse, hereinafter referred to as a character recognition pulse, is of a shape similar to the delayed index pulse. This pulse is applied to the character recognition pulse amplifiers.

(f) Character Recognition Pulse Amplifiers, Q848 and Q847 and Storage Release.

1. Q848, a common emitter amplifier, serves as a phase inverter for the character recognition pulse. The character recognition pulse, swinging from -20 to -7 volts, is applied through R935 to the base of Q848. Q848, normally held cut off by the -20 volt potential is driven into conduction by this character recognition pulse, causing its collector to swing from approximately +12 volts to -12 volts. This negative swing on the collector is coupled by means of C847 to the base of Q847.

2. Q847 is a common emitter amplifier, biased to cut off by +3 volts on the base. The negative pulse from C847 drives Q847 into conduction and the collector swings from -22 volts to 0 volts. This sharp pulse, approximately 25 microseconds, in duration, is the output character recognition pulse which is fed to the associated Thyratron Print Circuit unit. The character recognition pulse from the "A" Storage and Character Recognition unit, for example, goes through terminal 6 of J802 to the "A" Thyratron Print Circuit unit.

3. The output of Q847 is fed back to the bases of Q802, Q804 Q806, Q808, Q810, and Q812. This pulse triggers all the storage flip-flops back to the spacing condition, ready for the receipt of the next character.

(g) Printing Distributor, Q820 to Q844, and Drive Circuit Q819

1. The printing distributor is a 25 element distributor ring used to select one of the 25 thyratron circuits in the associated Thyratron Print Circuit unit, as shown in the functional block diagram, Fig. 2-11. The output of the A, B, C Distributor located in the Control Unit is received on terminal 20 of J801, clamped at -15 volts by means of CR870 and applied to C819 of the ringing circuit. These pulses are shown on lines Nos. 8, 13, and 18 on Fig. 2-27, for units "A", "B", and "C" respectively. They are regulated by the Control unit in a manner similar to the transfer pulses; however, they precede the transfer pulses by approximately 100 microseconds. Every character that takes up space in the printed line is accompanied by a printing distributor pulse. (This includes all characters to be printed and the Space function. The latter function, however, does not receive a transfer pulse because it need not be put into storage.)

2. The ringing and drive pulse amplifier circuits were covered in detail in paragraph II; 2: b: (4). The positive going (-15 to -7 volt) square-shaped, printing distributor pulse, energizes the ringing circuit; and the resulting 10 microsecond pulse is amplified by Q819, causing a swing from 0 to -12 volts to appear on its collector. This pulse is applied to the common emitters of the 25 element ring and, as was described in paragraph II; 2; b; (3), the ring is stepped one element for each input pulse. Assume, for example, that the first character in a line of type is being received, waveform No. 1 in the timing diagram, Fig. 2-27. The 25th elements of the printing distributor rings in all three units are "on", because they had been turned "on" by the Carriage Return function of the previous line. Upon receipt of the printing distributor pulse from the Control unit for the first character, the 25th element, Q894, in the "A" printing distributor is turned "off" and the first element, Q820, turned "on". The collector of Q820 swings from -17 volts to -7 volts (waveform No. 10). This output is connected to terminal 7 of J802, from where it is used to prime one of the control grids of the first thyratron circuit in the "A" Thyratron Print Circuit unit. Approximately 100 microseconds later, the transfer pulse comes in (waveform No. 9) and puts the character into storage. When the character is recognized, the character recognition pulse, which is impressed on the other control grid of all "A" thyratrons, fires the first thyratron in "A" unit and the character is printed by the first print hammer mechanism.

3. In the meantime, the second character is being received, and its printing distributor pulse is directed to the "B" unit. The 25th element in "B" printing distributor is turned "off", and the first element turned "on". The output of the first "B" element primes the first thyratron in the "B" thyratron unit. This thyratron is associated with the second print hammer mechanism. When the second character is recognized, the thyratron is fired, and the character is printed in the second position. The third character is printed in the third position by the cooperation of the "C" storage and thyratron units. Note that before the fourth character is received the printing period for the first character has expired, and "A" storage is empty. Therefore, the fourth character causes the "A" printing distributor to step to its second element (waveform No. 11). This second element primes the second thyratron in the "A" thyratron unit. When the character is recognized, the second thyratron, which controls the fourth print hammer mechanisms, is fired, causing the fourth character to be printed in the fourth position. This operation continues with the "A" units controlling printing in positions 1, 4, 7, 10, etc.;"B" units - positions 2, 5, 8, 11, etc.; and "C" units - 3, 6, 9, 12, etc. until the Carriage Return function starts the cycle over again.

(h) Carriage Return Function

1. Recognition and control of the Carriage Return function is carried out in the Control unit. Upon receipt of Carriage Return, the Control unit delivers a pulse at the proper time to the base of the 25th distributor element in the A, B, and C Storage and Character Recognition units. This sets all distributors for the next line of print.

2. Failure of a carriage return function to be received causes the printing to revert from position 75, at the end of the line, back to position 1, since the printing distributor closes on itself between elements No. 25 and No. 1. Position 75 is selected by the 25th printing distributor element (Q844) in "C" unit. When this 25th element is turned on, the collector output not only selects position 75, but also is delivered back to the Control unit (terminal 31, J802) where it initiates automatic Carriage Return-Line Feed if these functions had not been received.

3. The circuit, as described, controls the printing of a 75 character line, through three printing distributors having 25 elements each. Other length lines may be obtained by moving the base input and collector output connections from the 25th elements to other elements. A 26th element, Q845, is provided for those instances where a line of up to 78 characters is desired. For such use, the connection from terminal No. 22 of J801 through C847 would be moved from the base of Q344 to the base of Q845 and the connection through C821 to the base of Q820 would be moved from the collector of Q344 to the collector of Q845.

(i) Storage Anti-Lock-Up, CR871, CR872, CR874, CR875, CR876 and R952

1. The purpose of this circuit is to prevent locking up of the storage elements due to either of the functions "figures" or "letters" being placed into storage. As described in paragraph (c); (5); (g), the code combinations of functions will normally not be placed into storage, because generation of the transfer pulse is inhibited upon receipt of a function code combination. However, when power is first applied to the system it is possible for the storage elements to turn on in such a pattern as to result in a function combination being stored. When this occurs, a character recognition storage relase pulse will not be generated because recognition can take place only at the instant a character code combination is set up in the binary counter. Therefore, the function will not be cleared from storage. If succeeding code combinations change the stored combination to a character, recognition will take place and the entire storage cleared. However, should either of the function combinations "figures" or "letters" be placed into storage, the storage will become locked-up.

2. CR871, CR872, CR874, CR875 and CR876 comprise an AND gate with inputs from the mark amplifier outputs of storage elements No. 1, No. 2, No. 4 and No. 5. The incoming A, B, C, distributor pulse also serves as an input to this gate. Thus should the function combinations "figures" or "letters" be placed into storage the anti-lock-up gate will have -7 volt inputs applied to it from the four mark amplifiers. When the input from the A, B, C distributor swings from -20 to -7 volts, the gate will have a similar output. The output of the gate is differientiated by C818 and the positive pulse applied through CR873 to the base of Q802, the marking element of storage element No. 1. This pulse triggers the storage flip-flop back to the spacing condition, allowing recognition of the character combination now in storage to take place and resulting in the entire storage being cleared.

(4) Control Unit

(a) The general function of the Control unit was covered in paragraph II; 2; a; (2); c. As was seen in the description of the Storage and Character Recognition units, the main function of the Control unit is to direct the transfer and printing distributor pulses in accordance with the characters received. In addition to this the Control unit takes care of all functions. Schematic wiring diagram , Fig. 5-9, shows the circuits; and timing diagram, Fig. 2-28, illustrates the operation of the control unit. Inputs to the Control unit from the Receiving Distributor include mark and space potentials of the five code pulses (terminals 9 to 18 of J601) and a pulse (called the stop pulse) from the stop element of the start-stop distributor ring (Terminals 19). One other input comes from the 75th printing distributor element of the Storage and Character Recognition units and is used for automatic carriage return-line feed.

(b) Stop Pulse; Stop Pulse Inhibit Amplifier, Q618; and Distributor Drive Circuits, Q619.

1. The stop pulse from the Receiving Distributor unit comes in on terminal No. 19 of J601 and accompanies every character. This pulse is shown as waveform No. 2 in Fig. 2-28) and is responsible for initiating all Control unit operation. The pulse is connected

to two circuits: to function recognition circuits, which will be described in later paragraphs, and to circuits which generate transfer and printing distributor pulses.

2. The positive going stop pulse (-7 to -20 volts) is differentiated by C609,and a sharp positive spike is delivered to the emitter of Q618, a common base amplifier. Q618 is normally held cut off by -6 volts on the emitter. The positive spike drives Q618 into conduction, and the collector swings from -22 volts to about - 10 volts. This positive swing is fed to C611 of a ringing circuit that includes L601 and CR663. Note that the base of Q618 also has an input which comes from the function recognition gates. This is a positive going input which is differentiated into a positive spike by C610 and appears only upon receipt of a function character other than "Space". This pulse drives the base positive and inhibits the conduction of Q618 when the stop pulse is applied to C609. This is the action, previously mentioned, that prevents printing and spacing on functions by inhibiting the transfer and printing distributor pulses.

3. The distributor drive circuits are identical to those used in previous units and described in paragraph 2;b;(4). Q619 produces 10-microsecond pulses swinging from -1 to -12 volts at its collector. These pulses are used to drive the A, B, C distributor and also to trigger the transfer pulse generator.

(c) A, B, C Distributor, Q624 to Q626; and Indicator Circuit, Q620 and DS601

1. This is a three element distributor ring of the type previously used and described in detail in paragraph 2;b;(3). It is this circuit which directs the transfer pulses to the proper A, B, or C unit, and which produces the pulses for driving the ring distributors of the A, B, and C units.

2. The drive pulses are fed thru the common emitter resistor R656 to the emitters of the three elements. As each transistor is turned "on", its collector swings from -20 volts to -8 volts. Waveforms No.s 4, 6, and 8 show the outputs of the A, B, and C distributor elements respectively. These outputs serve two purposes: (1) They go out thru terminals Nos. 5, 6, and 7 of J602 to their respective Storage and Character Recognition units as printing distributor pulses. (Note that waveforms Nos. 4, 6, and 8 of Fig. 2-28 are the same as waveforms Nos. 8, 13, and 18 of Fig. 2-27.) (2) They direct the transfer pulses to the respective Storage and Character Recognition unit.

2. The distributor indicator consists of Q620 and DS601. This circuit is identical to the indicating circuits used in the other units. Q620 conducts and fires DS601, NE51 glow lamp, when the collector of distributor element Q624 is "on".

(d) Transfer Pulse Generator, Q621 and Q622

1. The negative 10-microsecond distributor drive pulses coming from the collector of Q619, in addition to driving the distributor, pass thru CR664 and C613 to the base of Q621. Q621 and Q622 comprise a univibrator circuit of the type described in paragraph 2;b;(6), with Q621 normally cut off and Q622 normally conducting. The only difference is that this univibrator is triggered by a negative pulse coming in on the base of the "off" transistor, Q621. The purpose of the circuit is to generate a transfer pulse which lags the distributor drive pulse by 100 microseconds.

2. When the circuit is triggered, the collector of Q622 swings from -7 volts to -17 volts and, after an operating period of about 100 microseconds, as determined by C615, R648, and R651, swings back to -7 volts. This pulse is shown as waveform No. 3 in the timing diagram. The positive going swing from -17 to -7 volts is differentiated by C616 and fed to Q623.

(e) Transfer Pulse Inhibitor, Q623, and Transfer Pulse Amplifier, Q630

1. The positive pulse from the transfer pulse generator thru C616 is impressed on the emitter of Q623, a common base amplifier, similar to Q618. Q623 is normally held cut off by -4 volts emitter bias, as determined by R652 and R653. The positive pulse on the emitter drives Q623 into conduction, swinging the collector from -20 volts to -8 volts. When a "Space" character is received, however, it is necessary to inhibit the operation of Q623. This is accomplished by connecting the output of the "Space" recognition gate thru C617 to the base of Q623. The positive square wave output (-17 volts to -7 volts) from the gate is differentiated by C617, whose time constant is long enough so that the base of Q623 is held sufficiently positive, for more than 100 microseconds, to prevent conduction. The reverse resistance of CR665 contributes to this time constant. Note in the timing diagram that the output of the space gate (waveform No. 10) has inhibited the "B" transfer pulse that would ordinarily have occurred for the 5th character. This will prevent the "Space" character from being transferred to storage. Meanwhile, the "B" distributor element steps the "B" printing distributor, causing the spacing over of one column of copy.

2. The output of Q623 goes directly to the base of Q630, the transfer pulse amplfier. This is a common collector amplifier

whose emitter follows the base and reproduces the input. The output from the emitter is the positive going transfer pulse swinging from -20 volts to -8 volts.

(f) Transfer Pulse Selector Gates A, B, and C and Transfer Pulse Amplifiers A, B, and C, Q627 to Q629

1. The function of the transfer pulse selector AND gates is to convey the transfer pulses to the proper Storage and Character Recognition unit as directed by the A, B, C distributor. The collectors of the three element distributor are connected to their respective selector gates. The other input to the gates is the transfer pulse from Q630. Recall that the transfer pulse lags the turning on of the distributor elements by 100 microseconds. A gate will have an output of -8 volts only upon coincidence of a -8 volt potential from a distributor element and similar potential from the transfer pulse. Referring to the timing diagram, observe that an "A" transfer pulse, waveform No. 5, occurs only when the "A" distributor element is "on", waveform No. 4. The same applies to the "B" and "C" transfer pulses.

2. The A, B, and C transfer pulse amplifiers, Q627, Q628, and Q629, are common collector amplifiers. The amplifiers reproduce the outputs of their respective selector gates, and output transfer pulses swinging from -20 volts to -8 volts appear on the emitters. The outputs of the A, B, and C transfer pulse amplifiers are connected to terminals Nos. 14, 15, and 16, of J602. From here they go to their respective Storage and Character Recognition units to actually put their associated characters into storage.

(g) Code Pulse Amplifiers, Q601 to Q605 and Q610 to Q614

1. These are common collector amplifiers whose inputs are the outputs of the five storage elements of the Receiving Distributor unit. Q601 to Q605 are the marking amplifiers for the five code pulses, and Q610 to Q614 are the spacing amplifiers. For example, when No. 1 code pulse is marking, the input to the base of Q601 is -7 volts, and the input to the base of Q610 is -20 volts. The emitter output potentials follow the base potentials.

2. The outputs from the ten code pulse amplifiers are connected to the function recognition gates in accordance with the code combination for each function. The latter gates are all AND gates for -7 volt potentials.

(h) "Space" Recognition Gate, CR624 to CR630

Five of the six inputs to the "Space" function gate are connected to the code pulse amplifiers which put out -7 volts when a "Space" combination is received (Nos. 1, 2, 4, and 5 spacing and No. 3 marking). The sixth input is the stop pulse, waveform No. 2 in the timing diagram. (The stop pulse is fed to all function recognition gates.) When "Space" function is received, the output pulse is the same duration as the stop pulse and swings from -17 volts to -7 volts. The output of the gate connects through CR630 to the transfer pulse inhibit amplifier, Q623, as previously described.

(i) "Blank" Function Recognition Gate, CR617 to CR623

The inputs to this gate comes from the code pulse amplifiers which put out -7 volts for a "Blank" combination (Nos. 1, 2, 3, 4, and 5 spacing). The output of this gate, through CR623, connects to the stop pulse inhibit amplifier, and, as described in paragraph (b) prevents operation of the A, B, C distributor and transfer pulse generator. Actually, CR623 connects to a common bus to which the outputs of all the function gates except "Space" are connected. This bus will be hereafter referred to as the "stop pulse inhibit bus".

(j) "Figures" Function Recognition Gate, CR608 to CR614; "Figures" Storage Circuit, Q607 and Q608; "Letters" Function Recognition Gate, CR601 to CR607; Sixth Pulse Amplifier, Q609

1. The inputs to the "Figures" function gate come from the code pulse amplifiers which put out -7 volts for the "Figures" combination, Nos. 1, 2, 4, and 5 marking and No. 3 spacing. One output from the gate comes thru CR614 to the stop pulse inhibit bus, and the other connects thru C604 and CR616 to the base of Q608. The output pulse from the gate is shown as waveform No. 11 in the timing diagram. When a "Figures" combination is received, it is necessary to add a sixth code pulse to the five code pulses of all subsequent characters, until a "Letters" combination is received.

2. Q607 and Q608, "Figures" storage, is a flip-flop circuit which is triggered by the output of the "Figures" gate. Q608 is normally conducting, with its collector at -7 volts; and Q607 is normally cut off, with its collector at -17 volts. C604 differentiates the positive pulse output of the "Figures" gate, and the resulting positive spike cuts off Q608 and triggers the circuit. The collector of Q607 swings from -17 to -7 volts, waveform No. 12 in the timing diagram. The output from this collector is connected to Q609, a common collector amplifier. Then the emitter of Q609, the sixth pulse amplifier, follows the -17 to -7 volt swing and puts out a -7 volt potential to terminal No. 3 of J602. This

output goes to the sixth storage element in the Storage and Character Recognition units and effectively changes the code from five units to six units. Another output from the emitter of Q609 goes to the "Motor Stop" (upper case H) and "Signal Bell" (upper case S) function recognition circuits.

2. The "Letters" function recognition gate puts out a -17 to -7 volt pulse upon receipt of a "Letters" combination (waveform No. 13). The output of the gate goes thru C601 and CR615 to the base of Q607 of the "Figures" storage flip-flop and triggers the circuit back to its normal state. The collector of Q607 then swings from -7 volts to -17 volts, removing the sixth pulse from the character recognition circuits. Following characters, therefore, are all registered as "Letters."

(k) "Carriage Return" Function Recognition Gate, CR638 to CR644; Carriage Return Delay Univibrator, Q637 and Q638; Carriage Return Pulse Amplifier, Q641; and Automatic CR-LF Delete Univibrator Q639 and Q640

1. The "Carriage Return" function gate puts out a -17 to -7 volt pulse upon receipt of Carriage Return combination. This pulse, waveform No. 14, is fed to the stop pulse inhibit bus and also thru C630 and CR675 to the base of Q637.

2. Q637 and Q638, comprise the carriage return delay univibrator circuit. The purpose of this circuit is to introduce a delay of approximately 30 milliseconds before the carriage return function is actually carried out. This delay is needed to allow time for printing the character received just before the Carriage Return Character. Refer to Fig. 2-27, the timing diagram of the Storage and Character Recognition unit, and observe that the maximum printing interval for any character is approximately equal to three line signal character periods. Therefore, the delay inserted must be between two and three character periods. A character period at 750 words per minute is 13.3 milliseconds. When the univibrator is triggered, the collector of Q637 swings from -7 volts to -17 volts, and, after the 30 millisecond operating period, swings back to -7 volts as shown in waveform No. 15 of Fig. 2-28. The pulse from the collector of Q637 goes to two places: (1) It is differentiated by C636 and fed to Q641. (2) It differentiated by C633 and fed to Q639.

3. Q641, the carriage return pulse amplifier, is a common emitter amplifier which is normally conducting with a collector potential at about -1 volt. The sharp positive pulse, resulting from the differentiation by C636 of the Q637 output, cuts off Q641. This produces a sharp negative spike on the collector swinging from -1 volt to about -20 volts. This pulse is the carriage return

pulse illustrated as waveform No. 16, and its function is to turn "on" the last elements of the A, B, C distributor and the three, 25 element printing distributors. This prepares the distributors for the next printing character which must go the "A" unit and be printed in the first position of the the next line. The output from the collector of Q641 is fed thru capacitors C637, C638, and C639, to terminals Nos. 9, 10, and 11, respectively, of J602 and thru C640 to the base of Q626. Q626, the "C" element of the A, B, C distributor is thus turned "on" by the carriage return pulse.

4. Q639 and Q640 comprise the automatic carriage return-line feed univibrator; with collector of Q639 normally at -7 volts and collector of Q680 normally at -17 volts. This univibrator is triggered by the output of Q637, as covered in paragraph 1, above. The output is taken from the collector of Q639 which swings to -16 volts when the circuit is triggered and remains there for the 1 millisecond operating period, when the circuit triggers back to normal, the collector of Q639 swings back to -7 volts. Waveform No. 17 shows this pulse, which is connected to the line feed delete gate. Its function will be covered in the description of the automatic carriage return-line feed feature.

5. Operation of the local carriage return key on either the keyboard unit on receiving-only base unit causes 0 to +12 volt pulse to be applied to C653. This pulse is differentiated by C653 and the positive impulse is applied through CR688 to the base of Q637. The carriage return delay univibrator is thus triggered causing operation of the carriage amplifier as described above and eventual turning "on" of the last elements of the A, B, C distributor and the three, 25 element printing distributors.

(1) "Line Feed" Function Recognition Gate, CR631 to CR637; "Line Feed" Amplifier, Q615; Line Feed and Recharge Pulse Generator, Q634 and Q635; and Line Feed Pulse Amplifier, Q633.

1. The Line Feed function gate puts out a -17 to -7 volt pulse upon receipt of the line feed combination. This pulse waveform No. 18, is fed to the stop pulse inhibit bus and the base of common collector amplifier Q615. The -17 to -7 volt pulse is reproduced at the emitter of Q615. With line feed switch S601 in the single line feed position, CR678 and CR672 pass only the positive leading edge of the pulse to C621 where it is sharply differentiated into a positive impulse. CR679 serves to clamp the impulse at -12 volts. The impulse is applied to the base of Q634.

2. Q634 and Q635, the line feed and recharge pulse generator, comprise a univibrator circuit. The collector of Q634 is normally at -7 volts and the collector of Q635 is normally at -17 volts. The purpose of this circuit is to generate a line feed pulse whenever the "line feed" signal is recognized.

In addition, when S601 is in the double line feed position, this circuit will generate a recharge pulse. Double line feed operation, will be described in following paragraphs. When the univibrator is triggered by the positive impulse applied to the base of Q634 from Q615, the collector of Q634 swings from -7 volts to -17 volts. This negative going voltage swing is passed by CR679, differentiated into a negative pulse by C629 and applied to the base of Q633 the line feed pulse amplifier. After an operating period of about four milliseconds, the univibrator circuit triggers back to normal, with the collector of Q634 swinging from -17 to -7 volts.

3. Q633, the line feed pulse amplifier, is a biased-to-cut off common emitter amplifier which is energized by the differentiated negative going pulse from Q634. The negative pulse causes Q633 to conduct momentarily, producing a 21 volt positive pulse at the collector. This pulse is fed to terminal No. 12 of J602, from where it goes to the "C" thyratron unit and fires the line feed thyratron.

4. Operation of the local line feed key on either the keyboard unit or receiving-only base unit causes a 0 to +12 volt pulse to be applied to C652. This pulse is differentiated by C652 and the positive impulse is applied through CR687 to the base of Q634. The line feed and recharge pulse generator is thus triggered causing operation of the line feed pulse amplifier and the firing of the line feed thyratron.

(m) Double Line Feed Pulse Generator, Q631 and Q632; and Recharge Pulse Amplifier, Q636.

1. When line feed switch S601 is in the double line feed position, the output of Q635 of the line feed and recharge pulse generator is connected to the recharge pulse amplifier Q636. Therefore, when the univibrator circuit triggers back to normal, 4 milliseconds after the generation of the line feed pulse, the collector of Q635 swings from -7 to -17 volts. This negative going voltage change is differentiated into a negative pulse by C627 and applied to the base of Q636, the recharge pulse amplifier.

2. Q636, the recharge pulse amplifier, is a biased to cut off common emitter amplifier which takes the negative pulse from Q635. A sharp positive pulse is produced on the collector and fed to terminal No. 13 of J602 from where it goes to the "C" thyratron.unit to fire the recharge thyratron. The purpose of the recharge thyratron is to provide a faster than normal recharge of the line feed selector magnet capacitors thus preparing the circuit for the second line feed operation.

3. When line feed switch S601 is in the double line feed position, it will be noted that the output from Q615 is fed not only to the line feed and recharge thyratron pulse generator resulting in the generation of a line feed pulse as described in paragraph (1); 2, but is also fed thru C622 and CR673 to the base of Q631.

Q631 and Q632, the double line feed pulse generator, comprise a univibrator circuit. The purpose of this circuit is to generate a second line feed pulse approximately 20 milliseconds after the first. When the univibrator is triggered the collector of Q632 swings from -17 volts to -7 volts and after 20 milliseconds switches back to -17 volts. This latter negative going voltage change is differentiated by C625, and the negative pulse applied to the base of Q633. As described in paragraph (1); 3, Q633 produces a 21 volt positive pulse which fires the line feed thyratron initiating a second line feed operation.

4. Double line feed may be used at all speeds up to and including 250 wpm, without change in operating routine. At 750 wpm, if a character to be printed should follow the line feed function it could be misplaced due to printing during the second line feed. Therefore, it is recommended that at this speed, two line feed signals should be transmitted and the automatic double line feed not be used.

(n) "Signal Bell" Function Recognition Circuit, CR645 to CR652

An output is obtained from the "signal bell" function gate when the "S" combination (1 and 3 marking, 2, 4, and 5 spacing) is received after a shift to figures. The upper case condition is indicated by Q609 which puts -7 volts on CR651 only after the figures combination has been received. The output of the gate swings from -17 to -7 volts and is connected thru terminal 2 of J602 to the "S" thyratron print circuit unit where it serves to fire the signal bell thyratron.

(o) "Motor Stop" Function Recognition Circuit, CR653 to CR660; Motor Stop Storage, Q616 and Q617; Motor Stop Amplifiers, Q642 and Q643.

1. When the "H" combination (3 and 5 marking, 1, 2 and 4 spacing) is received after a shift to figures, an output swinging from -17 to -7 volts is obtained from the "motor Stop" function gate, CR653 to CR660.

2. The motor stop storage circuit, Q616 and Q617, is a flip-flop with Q616 normally conducting and Q617 normally cut off. The purpose of this circuit is to control the operation of the motor stop relay located in the Keyboard and Receive-Only Base Units. The positive swinging output from the motor stop function recognition gate is differentiated by C605 and the positive pulse passed through CR661 to the base of Q616. This positive pulse triggers the motor stop storage flip-flop, causing the collector of Q617 to rise from -17 to -7 volts. The output of Q617 is applied to the base of Q642.

3. Q642 and Q643, motor stop amplifiers, are connected as common emitter amplifiers. Q642 is normally held cut off as a result of the -17 volt output from Q617. When the collector of Q617 swings from -17 to -7 volts, Q642 is driven into conduction and its collector swings from +12 to -12 volts. The output of Q642 is applied to the base of Q643 which is normally held cut off by the +12 volt potential. When the collector of Q642 swings from +12 to -12 volts, Q643 is also driven into conduction. The collector of Q643 is connected through pin 17 on J602 to the coils of the motor stop relay. When Q643 conducts, current flows in the relay coils, and the relay operates to open the power circuit to the motor on the printer unit.

4. When a reset pulse is applied through C608 and CR662 to the base of Q617, the motor stop storage flip-flop is returned to its normal condition with Q617 cut off. This causes the motor stop amplifiers to be cut off, de-energizing the relay and allowing the motor to start. The motor stop storage reset pulse is generated by the break recognition and storage circuits upon receipt of a "break" signal followed by a return to marking current on the signal line.

(p) Break Signal Timer, Q645 and Q646; Break Recognition Circuit, CR682 to CR684; Break Storage, Q647 and Q648.

1. The break signal timer, Q645 and Q646, is a univibrator circuit such as was described in paragraph 2; g; (6) except that a means has been provided to reset the univibrator to its normal condition anytime during the operating cycle. Q645 is normally conducting and Q646 is normally cut off. The inverted and normal signal outputs of the signal shaper circuit located in the Receiving Distributor Unit are applied to the break signal timer through pins 30 and 31 of J602. CR680 passes only the positive signal transitions of the inverted signal to CR643, where they are differentiated into sharp positive impulses which occur at the instant the line signal is making mark to space transistions. The impulses are applied to the base of Q645, cutting Q645 off and triggering the univibrator. The normal operating period of the univibrator is approximately 180 milliseconds. However, during receipt of traffic, the univibrator will be reset during the 180 millisecond period. CR681 passes only the positive signal transitions of the normal signal to C647, where they are differentiated into sharp positive impulses which occur at the instant the line signal is making space to mark transistions. The impulses are applied to the base of Q646, triggering the univibrator and causing it to return to its normal condition with Q645 conducting. Thus, during normal traffic the output of Q645 is identical with the normal signal waveform. But when a signal line break is received, Q645 after being cut off by the mark to space transition will return to its normally on condition after the 180 millisecond operating period of the univibrator although the normal signal waveform is still spacing.

2. The output of Q645 is applied to CR682 of the break recognition gate. The inverted signal output of the signal shaper and the output of the selection pulse generator also serve as inputs to this "and" gate. During marking intervals of normal traffic the output of the gate is held at -17 volts by the inverted signal input; and during spacing intervals by the collector output of Q645. However, when a spacing signal of 180 milliseconds or more is received, the collector of Q645 swings from -17 to -7 volts, fully priming the gate and allowing the selection pulse generator input to pass through.

3. Q647 and Q648 comprise the break storage flip-flop. Q647 is normally conducting and Q618 is normally cut off. The output of the break recognition gate is applied to CR685 where the positive transition is passed to C648 and differentiated into a positive pulse. This pulse triggers the flip-flop causing the collector of Q647 to swing from -7 to -17 volts. The purpose of this circuit is to store the fact that a break signal has been received. Upon return to marking current on the signal line, the positive transition of the normal signal is passed by CR686, differentiated by C649 and applied to the base of Q648. The flip-flop is triggered causing the collector of Q647 to swing from -17 to -7 volts. The output of Q647 is applied to the motor stop storage flip-flop and serves as the reset for this circuit.

(q) Automatic Carriage Return-Line Feed, Q639 and Q640

1. Normal operation requires that, on or before the 73rd character, two carriage return combinations and one Line Feed combination shall be received in order to shift the printing to first position of the next line. In case these combinations are not received, the automatic carriage return-line feed feature will perform the function. This is accomplished by recognizing when a printing or spacing character is to use the 75th printing position (25th element of the "C" printing distributor). Note that the Carriage Return half of the operation is obtained without additional circuits, because the "C" printing distributors are normally stepped to the 25th element by the 75th character. The output of the 25th "C" element then is used to generate a line feed pulse. This line feed pulse must be generated only when the 25th element is turned on by the 75th character, and not when it is turned on by a normal carriage return operation.

2. The output from the 25th element in "C" printing distributor; a positive going pulse swinging from -20 to -8 volts comes in to the control unit at terminal No. 8 of J602 and is applied to the base of common collector amplifier Q649. The emitter output of Q649 is differentiated by C641 and applied to the line feed delete gate. This is a two-input AND gate for -7 volt potentials. The other input comes from the collector of Q639 of the automatic CR-LF delete univibrator. When automatic carriage return is to be used, the collector of Q639 is at -7 volts at the time the 25th element in the "C" printing distributor is turned on. C641 differentiates the leading edge of the 25th element output into a positive spike. This spike is passed thru the gate to the base of Q615, the line feed amplifier, initiating operation of the line feed circuits as previously described.

3. Under normal carriage return operation the collector of Q639 is at -17 volts when the 25th element of the "C" printing distributor is turned on by the carriage return pulse, as described in paragraph (k); 4. above. This closes the gate to the pulse from the 25th element and automatic line feed is deleted.

(5) Binary Counter Unit

(a) The function of the Binary Counter unit is to deliver to the three Storage and Character Recognition units the code combination of each character on the typewheel as that character reaches the printing location. A six-stage binary counter circuit is driven by index pulses derived from pulse generators connected to the typewheel shaft of the printer unit, there being one character index pulse for each character on the typewheel. The outputs from the binary counter are the parallel code combinations of the various characters.

(b) Basic Principles of Binary Counting Circuit

1. A binary counter is a device which counts to the base 2, that is, there are only two digits with which to express a number. These digits are "zero" (0) and "one" (1). This is compared to the decimal system which has ten digits for expressing numbers.

Received	Binary
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010

Each stage of a binary counter can be in only one of two stages, either "0" or "1". A two stage counter, therefore, can represent numbers 0, 1, 2 and 3 or, in other words, can be in four possible combinations. Expanding this to a five-stage counter results in 32 combinations, and expanding to a six-stage counter results in 64 combinations. Note that the 32 possible combinations of a five-stage counter are identical to a five unit telegraph code. This relationship was described in paragraphs 2; a; (2); (d) and 2; c; (3); (c); and illustrated in Fig. 2-17 & 2-29. Generally, a one (1) in binary rotation is equivalent to a mark in the telegraph code, and zero (0) to a space.

2. A binary counting stage, therefore, must be a circuit, having two stable states, which can be triggered from one state to the other. The flip-flop circuit described in paragraph 2; b; (1) is a circuit which meets these requirements. Because a binary counter stage must be triggered from either state to the other by pulses arriving at only one input point, the triggering method is somewhat different from the method used for flip-flops.

(c) Binary Counter Stages, Q702, Q703, A706, Q707, Q710, Q711, etc.

1. Referring to the first binary counter stage in schematic wiring diagram Fig. 5-4. Q702 (spacing side) is conducting and Q703 (marking side) is cut off for the "zero" or "space" condition. The collector of Q702 is at -7 volts, and the collector of Q703, is at -20 volts. The positive swinging triggering pulse is received from amplifier Q725 or Q726 and applied to the junction of CR701, CR702, and R709. This junction is biased thru R709 to -22 volts. Since this is more negative than the potential at either collector, diodes CR701 and CR702 are biased in the reverse direction. The purpose of the two diodes is to direct the positive going trigger pulse toward the control element (base) of the conducting transistor only, in this case Q702. The trigger pulse raises the input junction potential from -22 volts to approximately -10 volts. Since the collector of Q702 is at -7 volts, CR701 remains cut off, and no appreciable change is felt thru CR701. The collector of Q703, however, is at -17 volts and this allows CR702 to conduct when the input junction goes more positive than -17 volts, swinging the collector potential to -10 volts. The connection from the collector of Q703 thru voltage divider R702 and R703 transfers this positive going change, with the aid of accelerating capacitor C701, to the base of Q702, cutting off Q702 and triggering the circuit to the other state with Q703 conducting and Q703 cut off. The next pulse will pass thru CR701, divider R707, and 708, and acelerating capacitor C703 to the base of Q703 cutting off the latter and triggering the circuit back to the space condition.

2. The complete binary counter is comprised of six interconnected stages, with the drive pulses being brought in only to the first stage. It counts from 0 to 63 (64 combinations of "1's" and "0's" or "marks" and "spaces"). The interconnection between stages is from the collector of the spacing side of the lowest numbered stage through a common collector spacing amplifier to the input circuit of the following stage. A positive pulse is obtained only when the collector of the spacing side swings from -20 volts to -7 volts. This occurs, for any one stage, on every other input pulse to that stage. Therefore, it takes one initial input pulse to trigger the first stage, two to trigger the second stage, four to trigger the third stage, eight for the fourth stage, etc.

(d) Index Pulse Amplifiers, Q725 to Q727

1. The index wheel on the typewheel shaft has three rows of teeth, and associated with each row is an electro-magnetic pickup. A pulse is generated in the winding of a pickup for each tooth that passes the pole face of the pickup. One row has 52 evenly spaced teeth, one tooth for each character on the typewheel; and the pulses generated are called character index pulses. These pulses are shown as waveform No. 1 in the timing diagram, Figure 21. If this were the only source of index pulses, one revolution would produce only 52 pulses; and the binary counter could be stepped to only a count of 52. The code combinations for nine of the characters on the typewheel, however, exceed the binary count for 52, while the codes for certain non-typing functions are included in the first 52 counts registered. Therefore, it is necessary to introduce ten more pulses into the counter input, from a separate source, corresponding to the nonprinting characters. These pulses occur in between the various character index pulses. Nine of the ten pulses are generated by the second row of teeth on the typewheel, and are shown in waveform No. 3 in the timing diagram. These are known as function index pulses.

2. One of the ten extra pulses is produced by the counter itself and is fed back to the input. This pulse occurs on the upper case "Space" combination, and steps the counter to the upper case "S" (Signal Bell) code combination. Waveform No. 16 illustrates this pulse. The added pulse only accounts for 62 of the possible 63 code combinations that could be set up by the binary counter. The one not mentioned, the all "marking," or upper case "letters shift" combination, would normally follow the upper case "V" or ";" character and would thus precede the all "spacing" "Blank" or "zero" combination. It, however, would serve no useful purpose, since the function of the counter was completed upon setting up the 62nd combination.

3. A third row on the index wheel contains one tooth which is used to generate a set zero pulse. This pulse sets the binary counter back to zero (all stages in spacing or zero state) and is shown as waveform No. 2 in the timing diagram. The pulse will return the counter to zero from any count, but under normal operation occurs only between the characters ";" and "E". Should the counter, however, happen to get out of phase with the typewheels, the set zero pulse brings it back into synchronism before more than one erred character can be printed.

4. The 52 character index pulses, nine function index pulses, and set zero pulse, are brought in thru terminals 1, 2 and 3, respectively, of J701. These -5 volt pulses are fed to bases of their respective amplifiers, all common emitter amplifiers. Q726 amplifies the 52 character index pulses, and Q725 amplifies the nine function index pulses. The outputs of Q726 and Q725, consist of positive going pulses swinging from -22 volts to -1 volt. These outputs are differentiated by C727 and C726, gated together by means of an OR gate consisting of CR726 and CR727, and fed to the input circuit of the first binary counter stage. As described above, these positive pulses trigger the first stage thru CR702 or CR701.

5. The set zero pulse goes to the base of Q727 which puts out a positive going pulse similar to that provided by Q725 and Q726. This pulse is clamped at -12 volts by CR729 and delivered thru differentiating capacitors C702, C706, C710, etc., to the bases of the "marking" sides of all six stages, driving all operated stages to the spacing, or "zero" state. The set zero pulse is strong enough to overpower any interconnecting pulse that is generated as a result of resetting a stage from "mark" to "space", thus insuring the setting up of the full "zero" combination in the counter.

(e) Character Index Pulse Delay, Q729, Q730, Q731 and Q732

1. In addition to driving the first stage of the binary counter, the positive going pulses swinging from -22 to -1 volts derived from the character index pulse amplifier Q726 also trigger the character index pulse delay circuit. The character index pulse delay circuit is a univibrator such as was described in paragraph 2; g; (6). Q729 is normally conducting and Q730 is normally cut off. Each positive drive pulse is fed through C728 to the base of Q729 triggering the circuit. The operating period of the univibrator is approximately 100 microseconds. The output of the collector of Q730 is a series of positive going 100 microsecond pulses, one for each character index pulse generated on the index wheel.

2. These pulses are differentiated by means of C731 and delivered to the base of Q731, a common emitter amplifier. Q731, normally held non-conducting by means of R779, is driven into conduction by the negative pulse resulting from the differentiation of the trailing edge of the output of Q731 is a series of positive pulses swinging from -22 to -1 volts, each pulse delayed approximately 100 microseconds from the character index pulses.

3. The output of Q731 is fed through a common collector amplifier Q732 and connected to terminal 4 of J701 from where it is delivered to the Storage and Character Recognition units to be gated with the outputs of the pulse recognition gates. As previously described in paragraph 2; c; (4), the delayed character index pulses insure that the character recognition gate will recognize a character only at the beginning of a change in code from the binary counter.

(f) Binary Counter Outputs and Output Amplifiers, Q701, Q704, Q705, Q708, Q709, Q712, etc.

1. As the index pulses drive the counter, the collector potentials indicate the count, and, consequently, the code combination of the character represented by the count. Waveforms Nos. 4 to 15 illustrate the collector potentials with respect to the index pulses. Note how the function index pulses change the count in between the character index pulses.

2. The potentials from the binary counter collectors are delivered to the bases of their respective marking and spacing output amplifiers. These are common emitter amplifiers whose emitters reproduce the pulse applied to their bases. The 12 outputs from the emitters are connected to terminals 2 to 13 of J702, from where they are delivered to the Storage and Character Recognition units to be compared with the code combinations in storage. In addition, outputs from the first five spacing amplifiers are used to drive the succeeding binary counter stage.

(g) Upper Case "Space" Feedback Gate

This is the circuit used to produce the single extra index pulse described in paragraph (d); 2. The input diodes of the AND gate, CR720 thru CR725, are connected to the proper output amplifiers for the delivery of a -7 volt potential only when the binary counter is stepped to "Space" combination. The gate supplies a -20 volt potential at all other times. The positive swinging pulse from the gate is applied through CR719 and C725 to the counter input and immediately steps the counter one additional count. Waveform 16 in the timing diagram shows this pulse.

Note in the collector waveforms of the first stage that immediately after the upper case "Space" index pulse turns the marking side off and the spacing side on, the pulse fed back from the gate reverses the state of the first stage.

(h) Counter Indicator Amplifier Q728, and Indicator Lamp

The output of the No. 6 marking amplifier is applied to Counter Indicator Amplifier Q728 which drives Indicator Lamp DS701. The lamp is thus lighted each time the counter goes through the last half of the counting cycle, and serves to show proper operation of the counting circuits.

(6) Thyratron Print Circuit Units, A, B, and C

(a) Three Thyratron Print Circuit units contain the circuits for energizing the selector magnets in the Printer unit. Each of the units is associated with a particular Storage and Character Recognition unit. The units are identical, except that "C" unit contains two extra thyratron circuits for operating the line feed mechanism, and "B" unit contains one extra circuit for energizing the signal bell magnet. There are 26 thyratron print circuits in each unit, 25 of which are being used in the AN/FGC-36, thus providing a maximum line of 75 characters.

(b) Schematic wiring diagram Fig. 5-7 illustrates the printing, line feed, and signal bell circuits. Priming potentials for grid No. 1 of each of the 25 printing thyratrons are brought in through terminals Nos. 1 to 25 from the associated Storage and Character Recognition unit. As previously described (paragraph 2;c;(3)), these potentials are derived from the printing distributor elements. For example, the printing of the first character in a line is controlled by the "A" unit, so the first element of the "A" printing distributor applies a -7 volt priming potential to terminal No. 1 of J1001 of the "A" Print Circuit Unit. This is delivered to grid No. 1 of V1001 by means of voltage divider R1031 and R1032, raising the grid potential from -8 volts to -2 volts. V1001, therefore, is primed for eventual firing by the character recognition pulse that comes in to terminal 17 of J1003. All the other thyratrons have -8 volts on their No. 1 grids, because their respective printing distributor elements apply -17 volts to the grid input circuits. The -8 volts keeps these thyratrons from being fired.

(c) Basic Thyratron Circuit

1. Fig. 30 . is a schematic diagram of the basic thyratron print circuit. Under quiescent conditions, V1001, a type 5696, is not conducting, and C1001 is charged to a full 300 volts. Upon receipt of a character recognition pulse, with grid No. 1 primed to -2 volts, the thyratron is fired and the plate

potential drops instantaneously from +300 volts to about +10 volts. C1001 immediately begins to discharge thru the selector magnet, while V1001 remains conducting, passing current both from R1001 and C1001. The inductance and resistance of the selector magnet, the capacitance of C100, and the low resistance of the fired thyratron form a series resonant circuit that is less than critically damped. R1001, being a relatively large resistance, does not appreciably affect the operation of the resonant circuit, but does supply current to the thyratron until the capacitor discharge current builds up.

2. The waveforms shown in Figure 30 demonstrate the operation. Initially, all the energy is stored in C1001. The discharge of C1001 builds up the pulse of current that flows thru the selector magnet and the tube. When the current reaches a peak, all the energy that was available in the capacitor has been transferred to the magnetic field of the selector magnet. The current then begins to decrease, but the action of the inductance is to try to keep it flowing in the same direction, thus charging C1001 in the opposite direction to its original condition. The collapse of the magnetic field delivers energy back to the capacitor, and the point is soon reached where the current in the coil again is zero. Due to losses in the circuit, the peak voltage across the charged capacitor is only a fraction of the original potential difference. C1001 then discharges again, but in the opposite direction to the original discharge. Since this discharge current is in the wrong direction to pass thru the thyratron, it is drawn from the +300 volt power supply thru R1001 causing an increased drop across R1001. This drives the plate of V1001 in the negative direction and extinguishes the thyratron. C1001 continues to discharge thru the zero potential condition and then recharges thru R1001 and the selector magnet to the original +300 volts.

3. With the low resistance of the conducting thyratron removed from the circuit, the large resistance of R1001 now becomes dominant and takes the resonant circuit out of the oscillatory condition and puts it in the overdamped condition. Therefore, after the thyratron is extinguished, C1001 recharges exponentially with the value of R1001 being a controlling factor in the rate of charge. R1001 is a slide-wire rheostat by which the value of the recharging current can be varied. Since the charging current also flows thru the selector magnet, it produces an exponentially decaying magnetic field which exerts a small force on the selector magnet armature. By this time, the armature has almost been attracted as the result of the initial current pulse, which was in the form the first half cycle wave of a damped oscillation. (See Section II; c; 2;(a)paragraphs (5),, (6), and (7) for description of magnet operation.)
The recharge current that follows the operating current pulse has a negligible effect on the armature pull up.

4. The outputs of the thyratron print circuits connect to terminals Nos. 1 to 25 from where they are cabled to their respective selector magnets in the printing unit.

(d) Signal Bell and End of Line Bell, V1027

1. This is a thyratron circuit that is practically identical to the print circuit. The main differences are that grid No. 5 is strapped to the cathode, meaning that only a pulse on grid No. 1 is required to fire the tube, and that the output from C1027 goes to the operating magnet of the signal bell mechanism, which is mounted in the Printing unit cabinet.

2. The output of the signal bell function recognition gate in the Control Unit is applied to terminal 16 of J1003, differentiated into a positive spike by C1056 and applied to grid No. 1 of V1027. R1108 and R1109 bias grid No. 1 to -8 volts.

3. The output of the end of line recognition gate in the Transmitting Distributor is applied to terminal 27 of J1001, differentiated into a positive spike by C1060 and applied to grid No. 1 of V1027.

4. The signal bell circuit is located in unit B and is shown within a dotted line block on the schematic wiring diagram.

(e) Line Feed Circuit, V1028 and V1029

1. The line feed circuit is located in "C" unit. V1028 occupies the same space in "C" unit that V1027 occupies in "B" unit. V1028 is the thyratron used to energize the line feed magnet on the printer by discharging C1028 and C1029, and V1029 is used to recharge C1028 and C1029.

2. The operation of V1028 is identical to that of the print circuits, except that only one input is required for firing. This input comes from the line feed recognition circuits of the Control unit to terminal No. 14 of J1003 and is a positive going pulse swinging from -20 volts to 0 volts. The pulse is differentiated by C1057 into a sharp spike. The plate of V1028 is connected to terminal No. 11 of J1003, from where it goes to the line feed magnet. The return from the magnet comes in on terminal No. 12 and connects to C1029 and C1028, parallel capacitors totaling 5 MF. Note that this is the same as the print circuit, except that the capacitor and magnet are transposed. The resulting current pulse energizes the line feed magnet, whose armature trips the line feed clutch as described in paragraphs (4), (5), and (6) of Section II; c; 2;(d;)

3. Capacitors C1028 and C1029 would not recharge fast enough if allowed to recharge thru a plate circuit resistor, as in the print circuits. Therefore V1029 is used to recharge the capacitors from +300 volts thru R1029. R1029 is adjusted low enough to enable fast recharge. V1029 is fired by a 20 volt pulse (-20 to 0 volts) which comes from the line feed circuits of the Control unit. This pulse comes in on terminal No. 13 of J1003 and lags the line feed pulse by 4 milliseconds. The lag is necessary in order to allow V1028 to be extinguished. Grid No. 1 of V1029 is biased to -45 volts thru R1111. Fig. 2-31 22 shows the complete circuit along with waveforms. Note that when V1028 is extinguished, the potential on the cathode of V1029 is approximately -40 volts and begins to climb exponentially toward +300 volts, as C1028 and C1029 charge. This rate of charge is determined by R1028. When the recharge pulse fires V1029, the majority of the recharge current comes thru V1029, with the lower resistance of R1029 accelerating the recharge of C1028 and C1029. V1029 conducts until the capacitors are charged, at which time there is no more plate to cathode potential to sustain conduction.

4. The 6.3 volt A.C. filament voltage for V1029 comes from a separate, floating, transformer secondary in the Power Supply. This is necessary because the cathode to filament potential may be +300 volts and this would have damaging effect on the tube. Therefore, the cathode is connected to one side of the filament.

(7) Power Supply Unit

(a) Low Voltage Supply, T101

1 Control Transformer, T101 supplies the following DC and AC voltages:

Voltage	Max. Load
+75	40 ma
+22	20 ma
+12	50 ma
+3	300 ma
-45	80 ma
-22	1.2 amp
-15	4 ma
-12	80 ma
6.3 AC	500 ma

2 Alternating current input power (nominal 110 volts) is applied through TB101 to power switch S104, through input fuses F106 and F112 to control transformer T101 and line level adjust tap switch S102. Nine taps on S102 provide an adjustment of ±8% from the nominal 110 volts input. When S102 is set so that the meter indicator, M101 is aligned with the red line, the correct tap is automatically selected to deliver the correct output voltages.

3 The desired DC output voltages are obtained by connecting full wave rectifier circuits to the appropriate taps on the multiple tapped secondary of T101. Each voltage is obtained from a separate rectifier except -15 volts, which is obtained from the -22 volt supply by means of a voltage divider. Each DC voltage output except +3 volts and -45 volts contains a variable resistor for fine adjustment of the voltage value.

4 A special ungrounded 6.3 volt AC supply is obtained from a separate secondary winding on T101, and is used to supply to filament voltage to the line feed recharge thyratron V1029 located in the "C" Thyratron Unit.

(b) Test Voltage Supply, T102 and T103

1 Variable autotransformer, T102, and control transformer, T103 comprise the test voltage supply. Its purpose is to provide a continuously variable DC output to be used for checking the operating limits of the individual transistor circuit units.

2 Input power from the primary of T101 is applied through test voltage switch S105 to T102. The adjustable output of T102 is applied to T103, rectified, filtered and delivered to pin 7 of J103

(c) Filament Voltage Supply, T104

Filament transformer T104 provides 6.6 volts AC with respect to ground on pins 3 and 4 of J104.

(d) High Voltage Supply, T105

1 Metallic rectifier transformer T105 comprises the high voltage portion of the power supply. Its purpose is to provide a +300 volt plate potential to the thyratron units.

2 Input power from the primary of T101 is applied through pin 20 of J103 to the motor control relay and motor switch, and then applied through pin 19 of J103 to the control winding of time delay relay K101. K101 delays the 300 volt output approximately 30 seconds from the delivery of filament supply. When the normally open contacts of K101 are closed, input power from the primary of T101 is applied through high voltage switch S107 to transformer T105. S107 provides an on-off control of the 300 volt output independent of the time delay relay. The output

of T105 is rectified by CR115, filtered and applied through fuse F111 to pin 1 of J104. Light indicator DS101 serves as a blown fuse indicator.

(e) Monitoring Facilities

1 All of the DC output voltages are metered by a special double-range voltmeter M103, and selector switch S103. Voltages 300, 75 and -45 are checked on the high range of M103, the balance on the low range. The test voltage is checked on either of the two scales as desired.

2 The transmit and receive DC line signals are checked on milliammeter M102. Selector switch S101 connects the meter to the transmitting and receiving distributor units. M102 is a 0 to 1 milliampere instrument calibrated for 0 to 100 milliamperes to cover conventional 20 and 60 ma telegraph signals. Only the low voltages developed across 10 ohm shunts in the signal circuits are applied to the meter. Monitoring jacks J101 and J102 are connected to M102 for the purpose of oscilloscope monitoring.

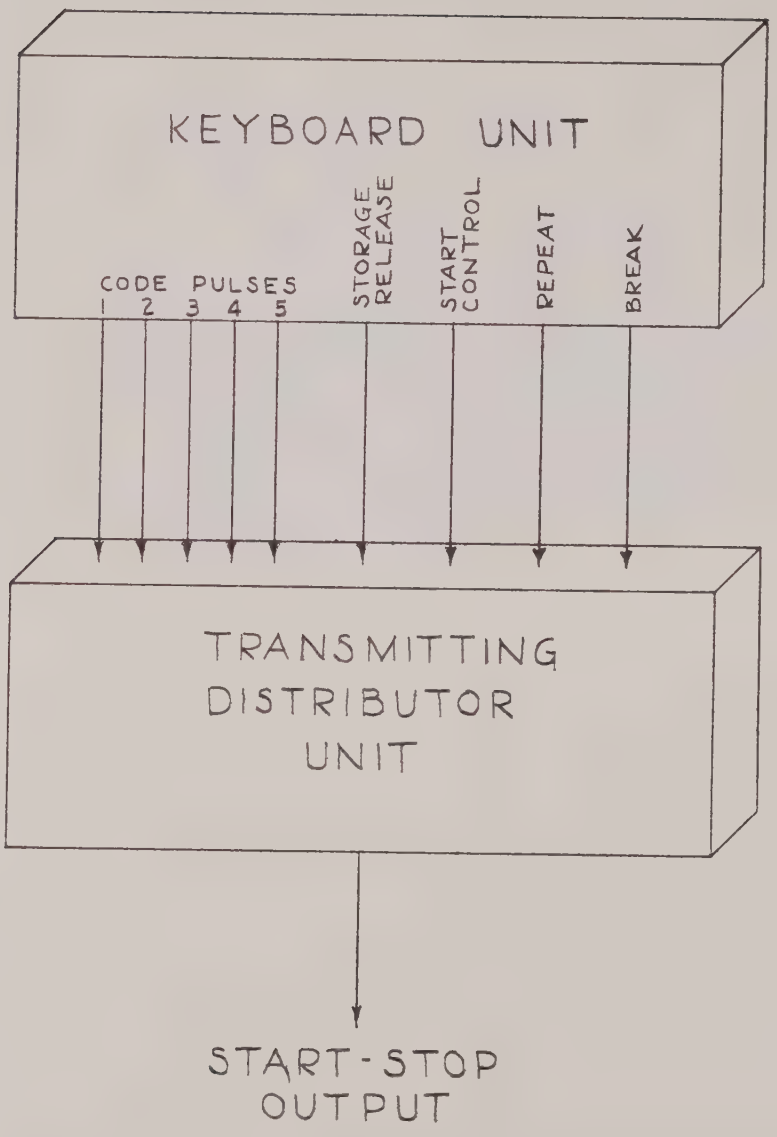


FIGURE 2-10
FUNCTIONAL BLOCK DIAGRAM OF TRANSMITTING PORTION OF AN/FGC-36

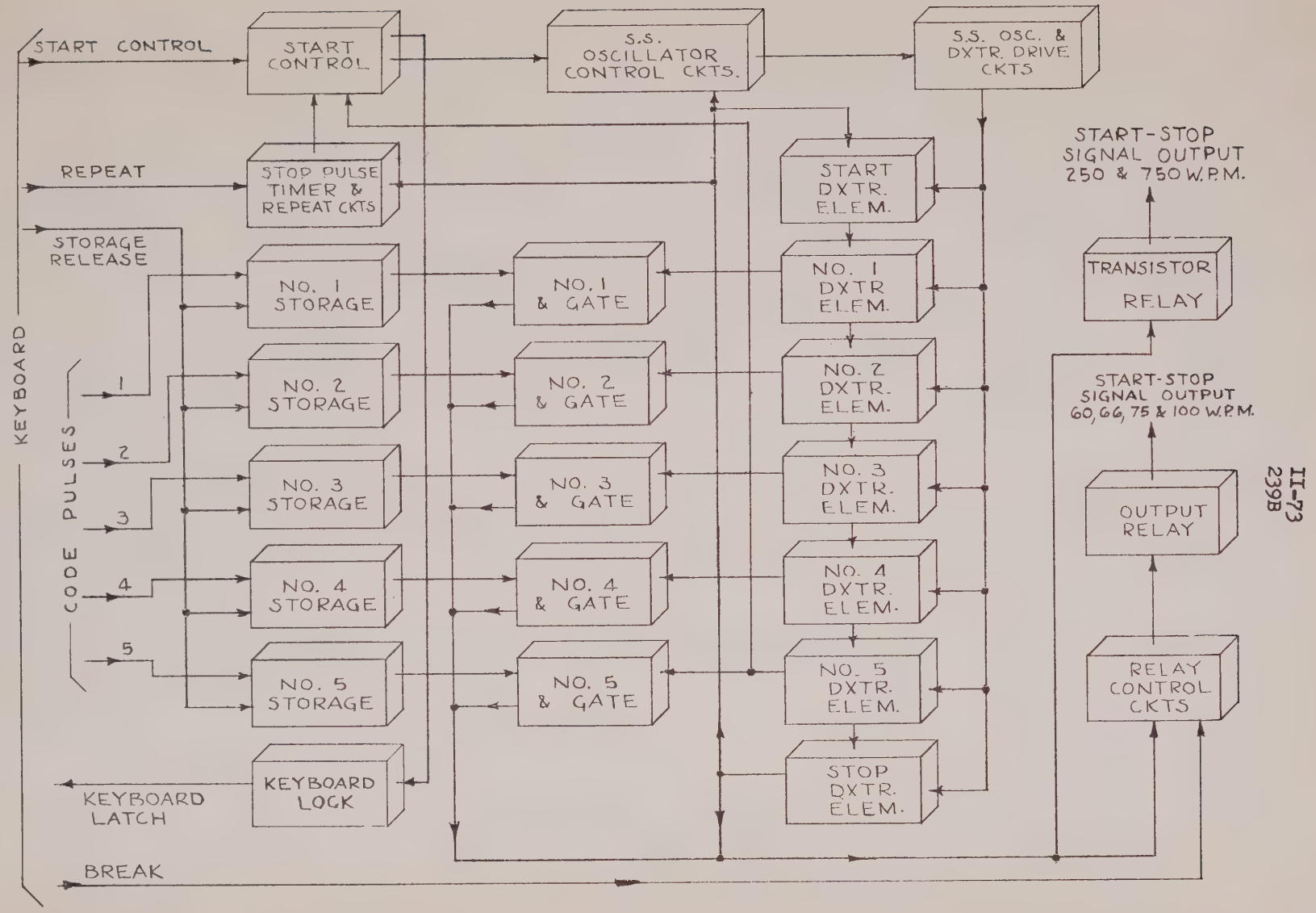
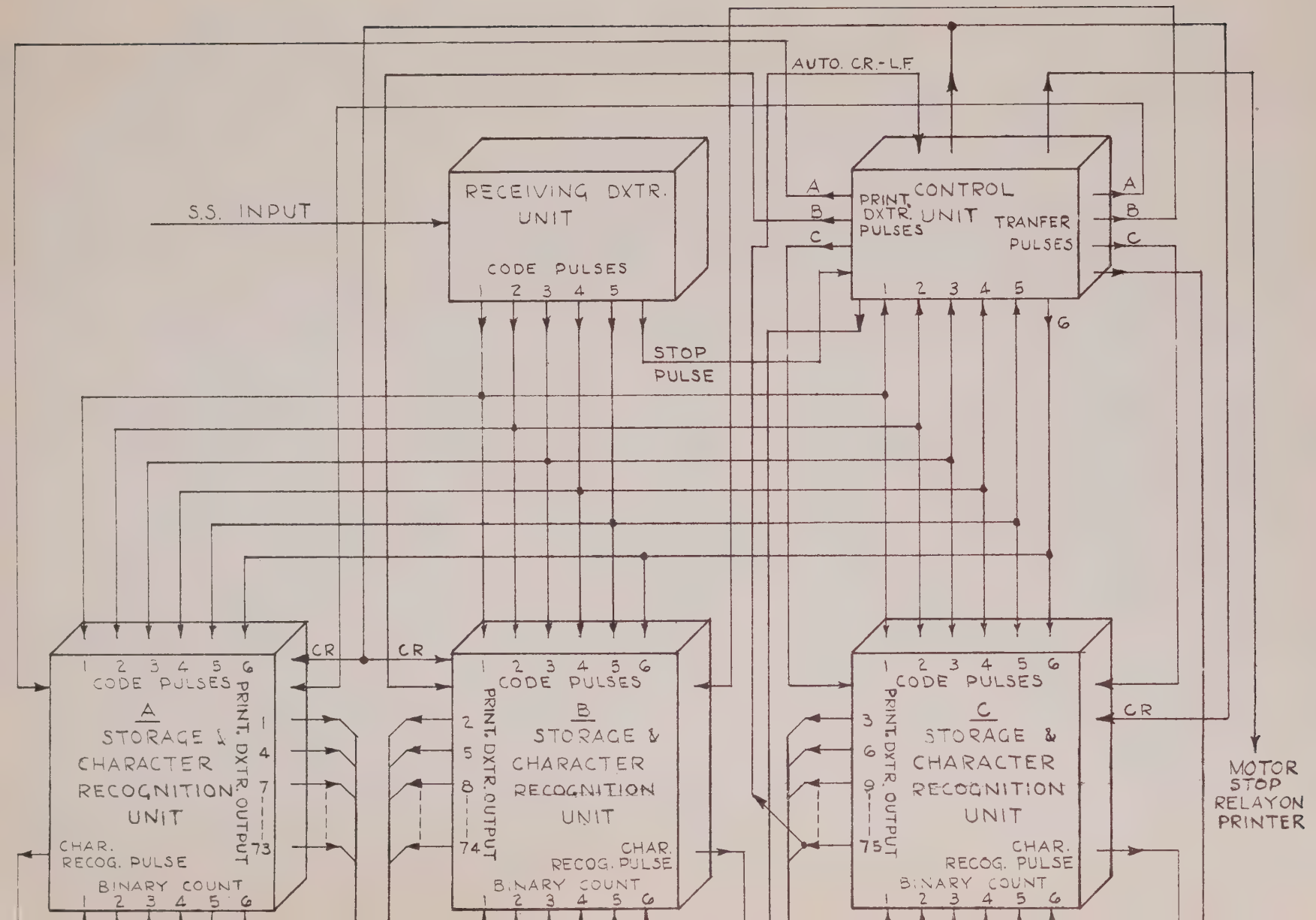


FIGURE 2-11
BLOCK DIAGRAM OF TRANSMITTING DISTRIBUTOR.


AUTO. CR.-L.F.
S.S. INPUT
RECEIVING DXTR. UNIT
CODE PULSES
1 2 3 4 5
STOP PULSE
CONTROL UNIT
PRINT. DXTR. PULSES
TRANFER PULSES
A
B
C
1 2 3 4 5 6
CR
CR
CODE PULSES
A
STORAGE & CHARACTER RECOGNITION UNIT
PRINT. DXTR. OUTPUT
1 4 7 73
CHAR. RECOG. PULSE
BINARY COUNT
B
STORAGE & CHARACTER RECOGNITION UNIT
2 5 8 74
C
STORAGE & CHARACTER RECOGNITION UNIT
3 6 9 75
MOTOR STOP RELAY ON PRINTER

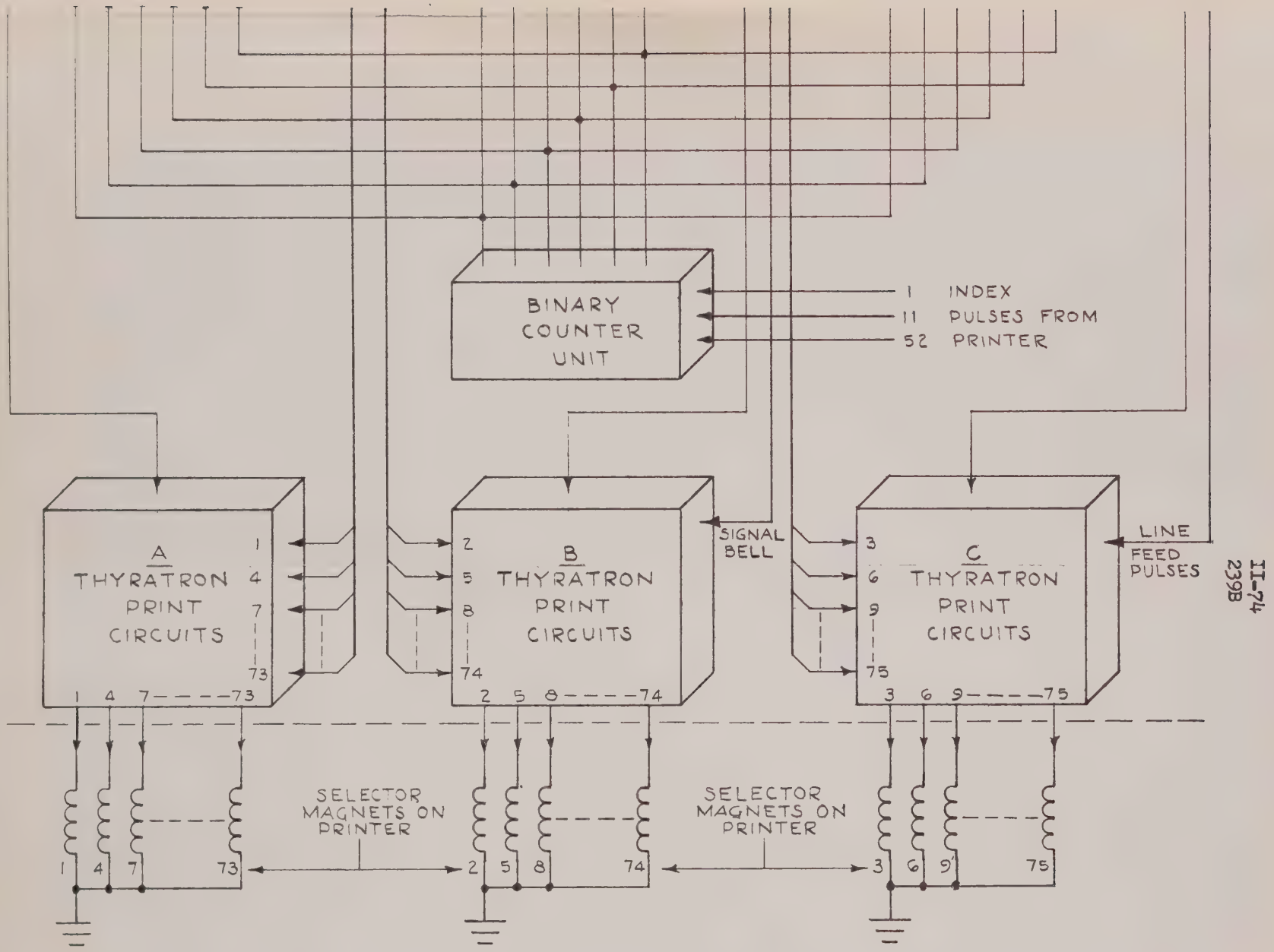


FIGURE 2-12
FUNCTIONAL BLOCK DIAGRAM RECEIVING
PORTION OF AN/FGC-36

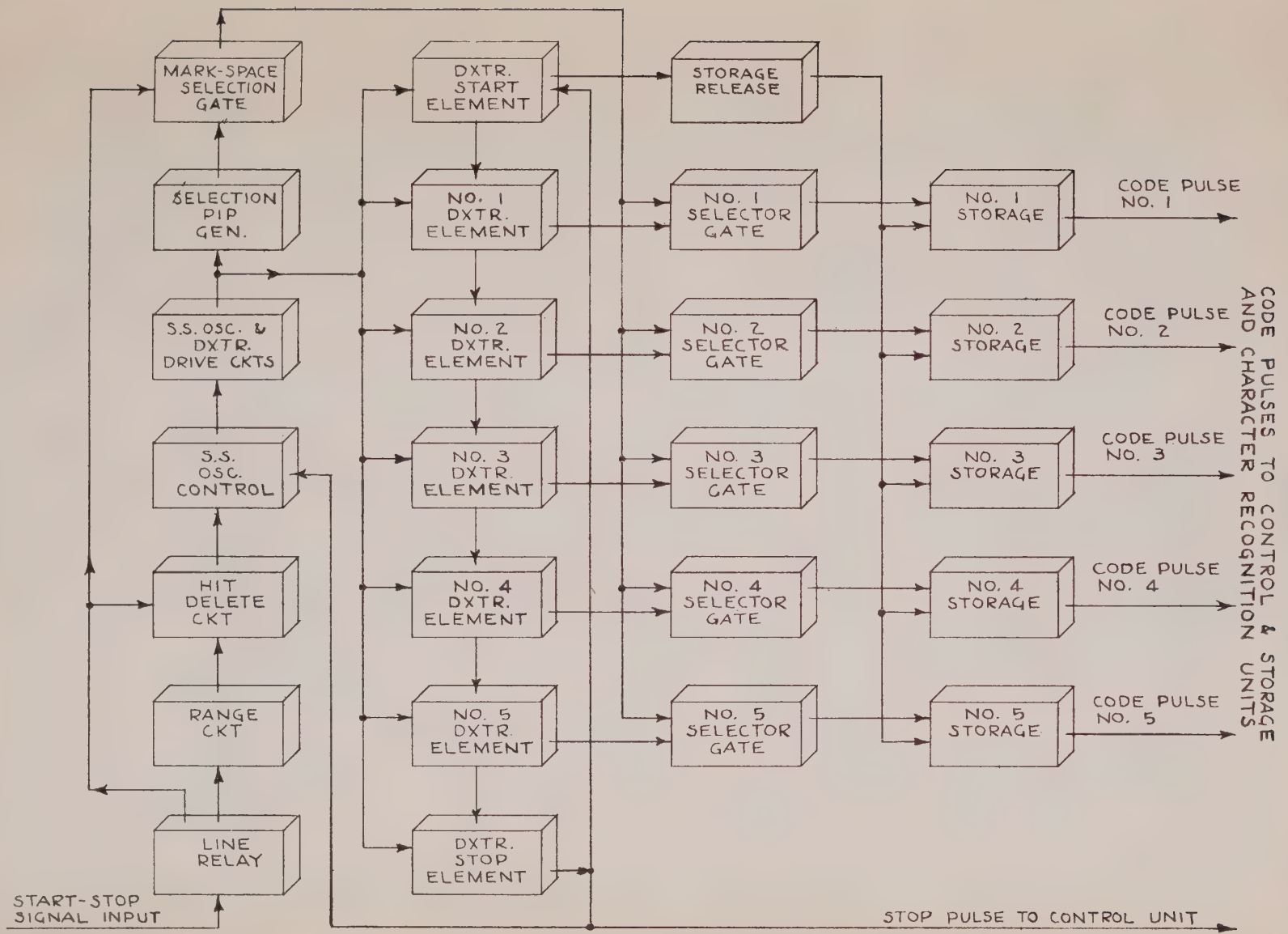


FIGURE 2-13
RECEIVING DISTRIBUTOR UNIT

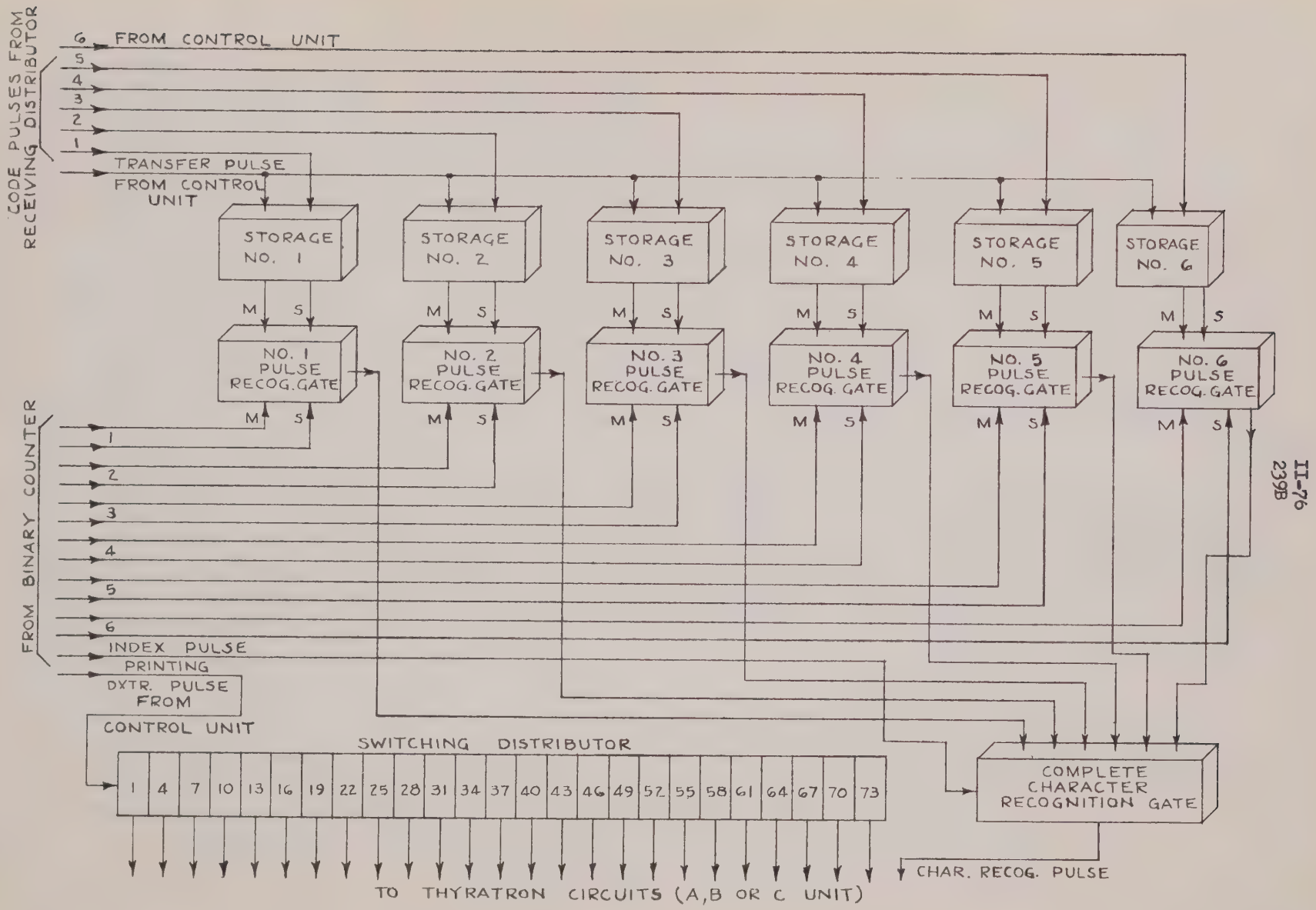


FIGURE 2-14 STORAGE AND CHARACTER RECOGNITION UNIT (A,B OR C)

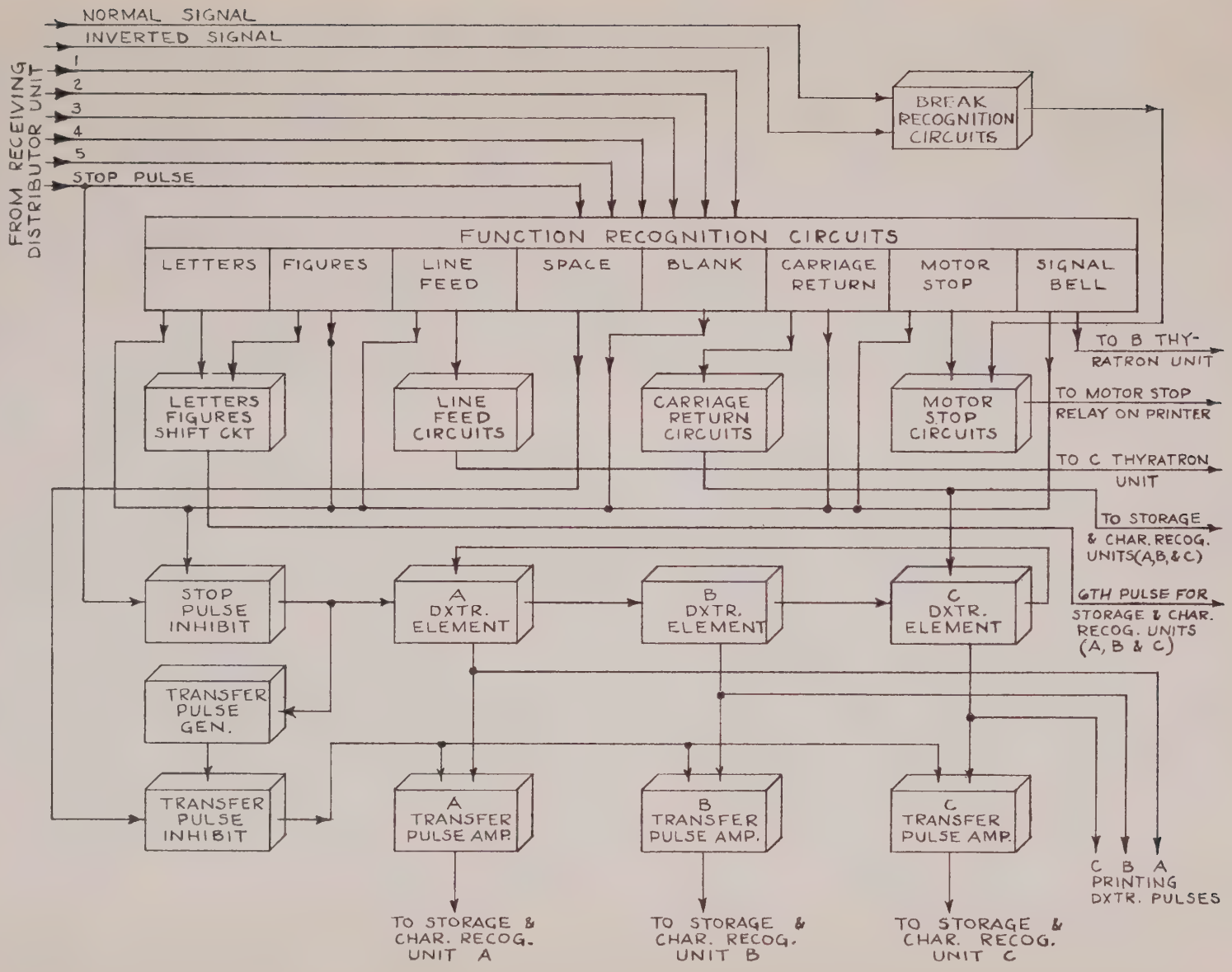


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FIGURE 2-15 CONTROL UNIT

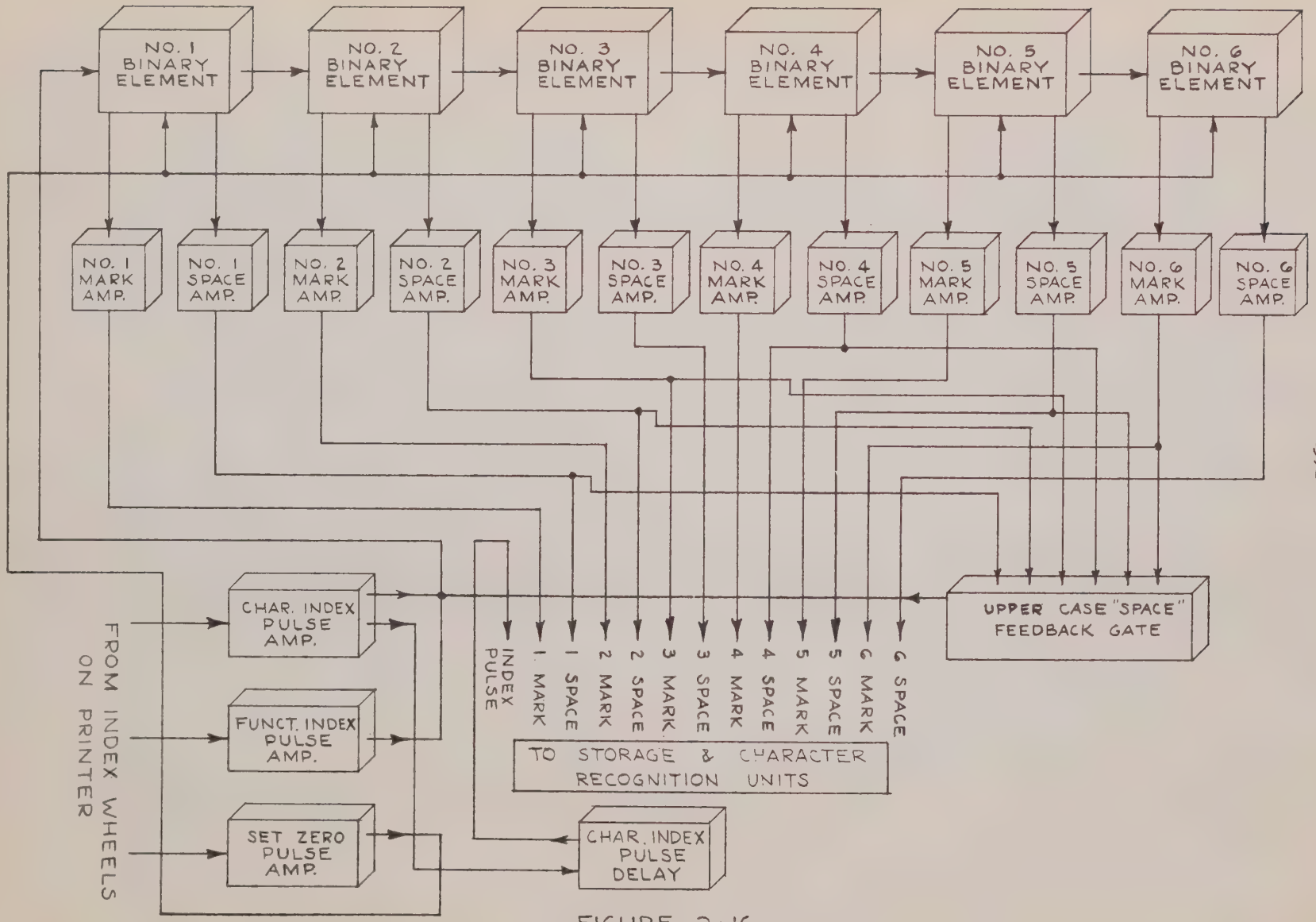

FIGURE 2-16
BINARY COUNTER UNIT

	6	5	4	3	2	1		
0	0	0	0	0	0	0	BLANK	*
1	0	0	0	0	0	1	E	
2	0	0	0	0	1	0	LF	*
3	0	0	0	0	1	1	A	
4	0	0	0	1	0	0	SPACE	*
5	0	0	0	1	0	1	S	
6	0	0	0	1	1	0	I	
7	0	0	0	1	1	1	U	
8	0	0	1	0	0	0	CR	*
9	0	0	1	0	0	1	D	
10	0	0	1	0	1	0	R	
11	0	0	1	0	1	1	J	
12	0	0	1	1	0	0	N	
13	0	0	1	1	0	1	F	
14	0	0	1	1	1	0	C	
15	0	0	1	1	1	1	K	
16	0	1	0	0	0	0	T	
17	0	1	0	0	0	1	Z	
18	0	1	0	0	1	0	L	
19	0	1	0	0	1	1	W	
20	0	1	0	1	0	0	H	
21	0	1	0	1	0	1	Y	
22	0	1	0	1	1	0	P	
23	0	1	0	1	1	1	Q	
24	0	1	1	0	0	0	O	
25	0	1	1	0	0	1	B	
26	0	1	1	0	1	0	G	
27	0	1	1	0	1	1	FIGS.	*
28	0	1	1	1	0	0	M	
29	0	1	1	1	0	1	X	
30	0	1	1	1	1	0	V	
31	0	1	1	1	1	1	LTRS.	*

	6	5	4	3	2	1		
32	1	0	0	0	0	0		
33	1	0	0	0	0	1	3	
34	1	0	0	0	1	0		*
35	1	0	0	0	1	1	-	
36	1	0	0	1	0	0		*
37	1	0	0	1	0	1	BELL	*
38	1	0	0	1	1	0	8	
39	1	0	0	1	1	1	7	
40	1	0	1	0	0	0		*
41	1	0	1	0	0	1	$	
42	1	0	1	0	1	0	4	
43	1	0	1	0	1	1	'	
44	1	0	1	1	0	0	,	
45	1	0	1	1	0	1	!	
46	1	0	1	1	1	0	:	
47	1	0	1	1	1	1	(	
48	1	1	0	0	0	0	5	
49	1	1	0	0	0	1	"	
50	1	1	0	0	1	0	)	
51	1	1	0	0	1	1	2	
52	1	1	0	1	0	0	MOT. STOP	
53	1	1	0	1	0	1	6	
54	1	1	0	1	1	0	Ø	
55	1	1	0	1	1	1	1	
56	1	1	1	0	0	0	9	
57	1	1	1	0	0	1	?	
58	1	1	1	0	1	0	←	
59	1	1	1	0	1	1		*
60	1	1	1	1	0	0	.	
61	1	1	1	1	0	1	/	
62	1	1	1	1	1	0	;	
63	1	1	1	1	1	1		*

* THESE CHARACTERS DO NOT HAVE SPACES ON THE TYPEWHEEL

FIGURE 2-17 BINARY COUNTER COMBINATIONS AND CORRESPONDING CHARACTERS

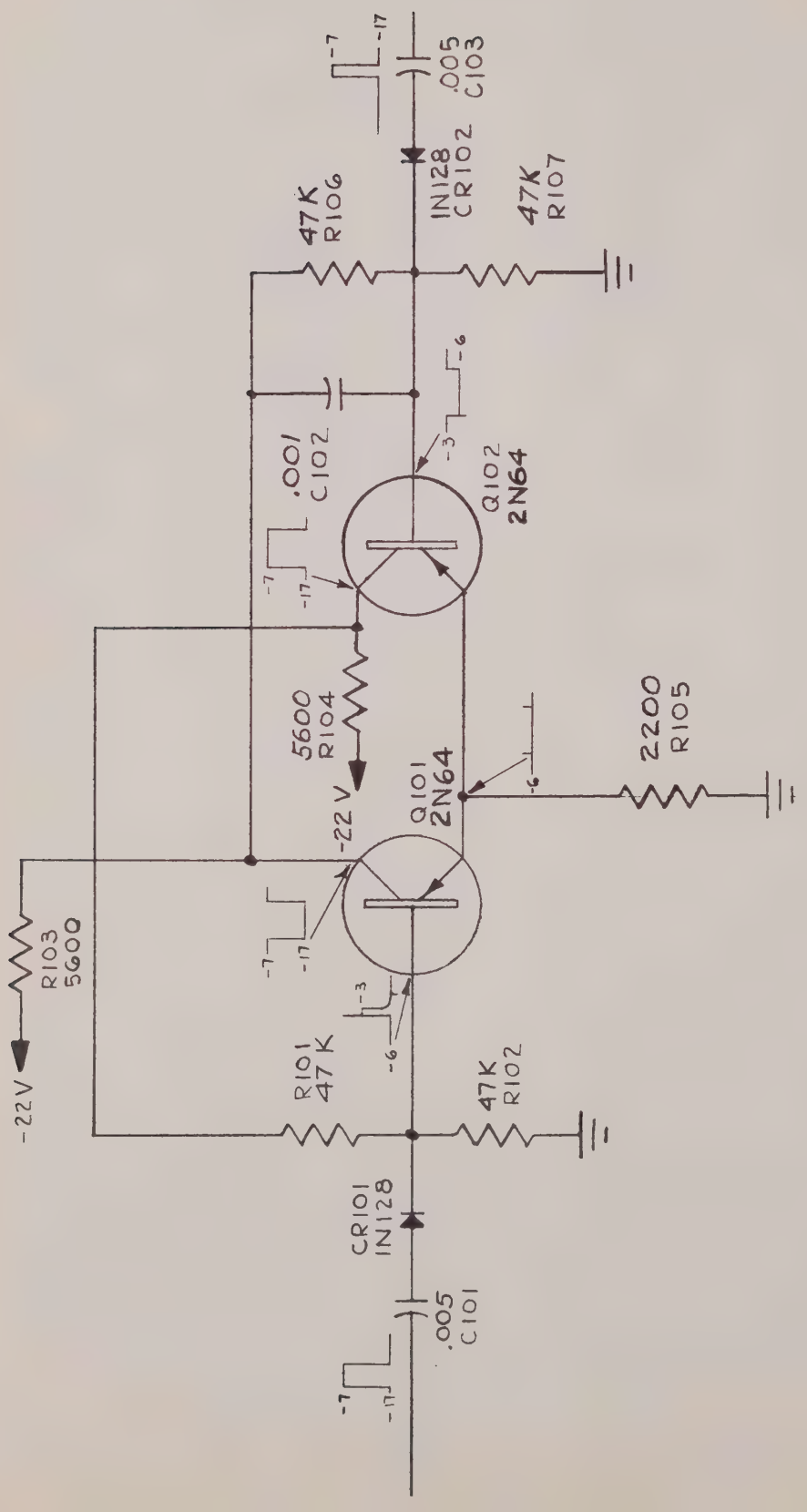

FIGURE 2-18 FLIP FLOP CIRCUIT

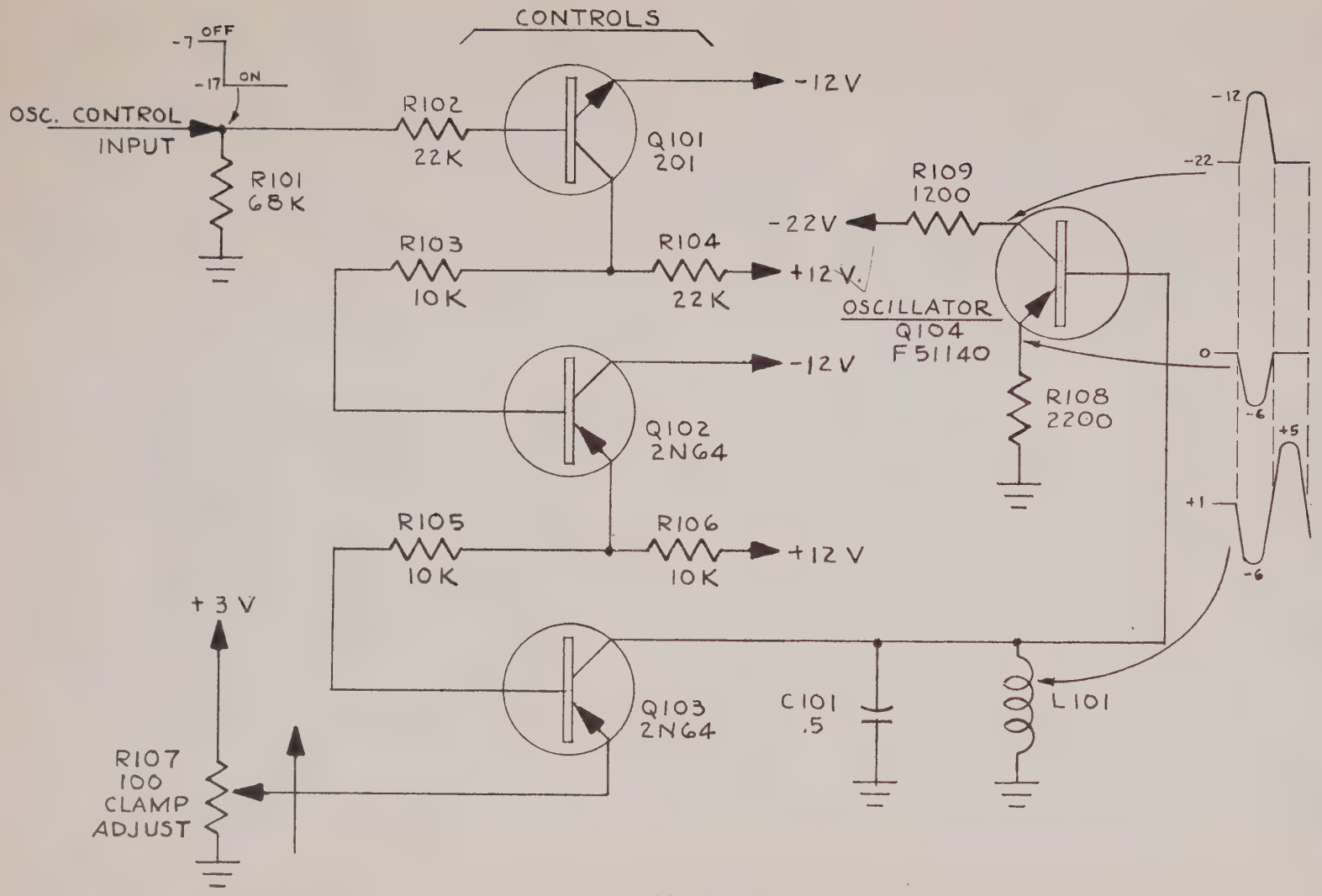

FIGURE 2-19
START-STOP OSCILLATOR AND CONTROL CIRCUITS

NOTE: THESE ARE IDEAL CURVES. LOAD LINES ARE USED FOR EXPLANATORY PURPOSES ONLY AND DO NOT NECESSARILY REPRESENT ACTUAL CIRCUIT CHARACTERISTICS.

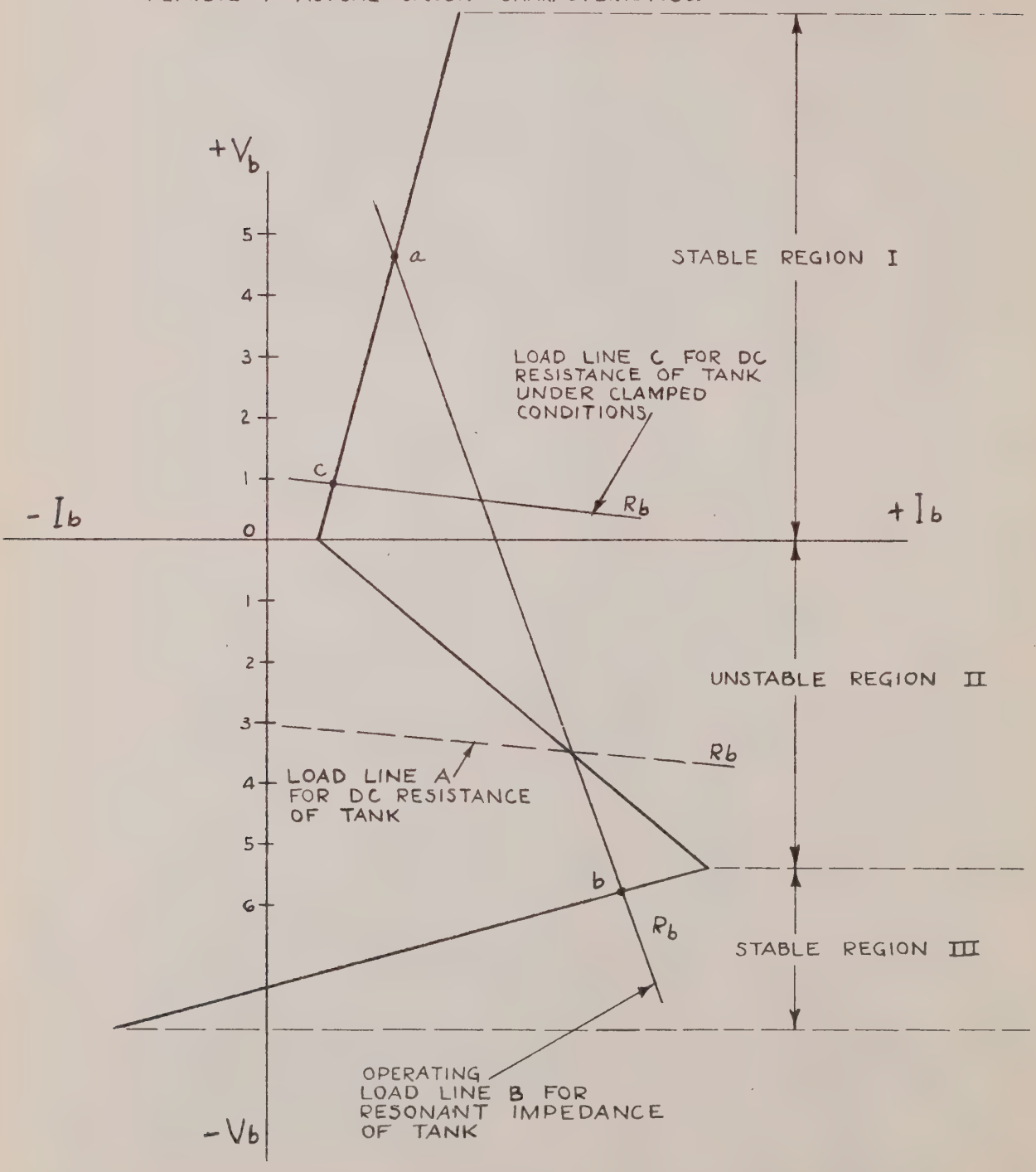

FIGURE 2-20 NEGATIVE RESISTANCE BASE CHARACTERISTIC OF POINT CONTACT TRANSISTOR

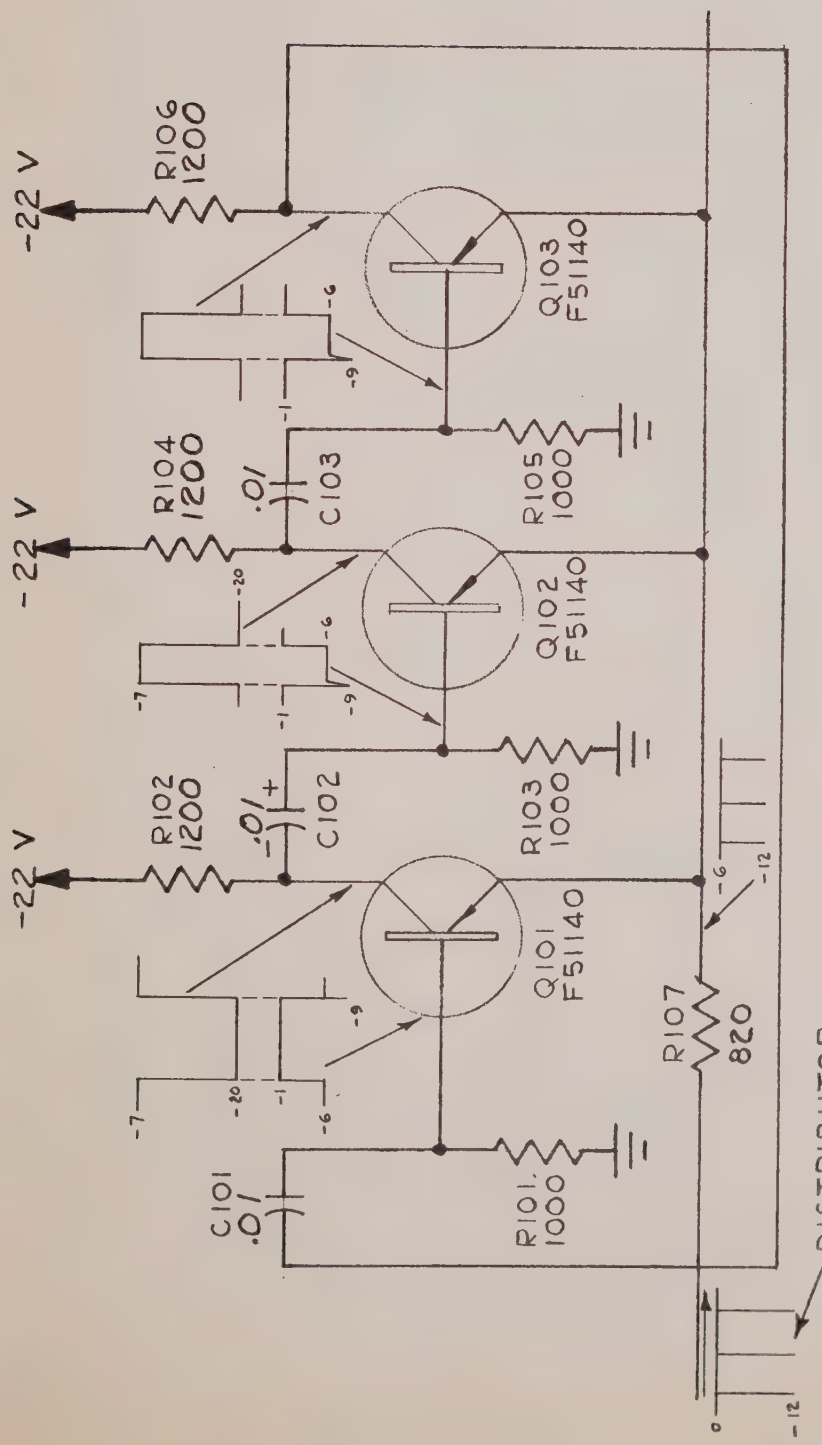

FIGURE 2-21 DISTRIBUTOR RING

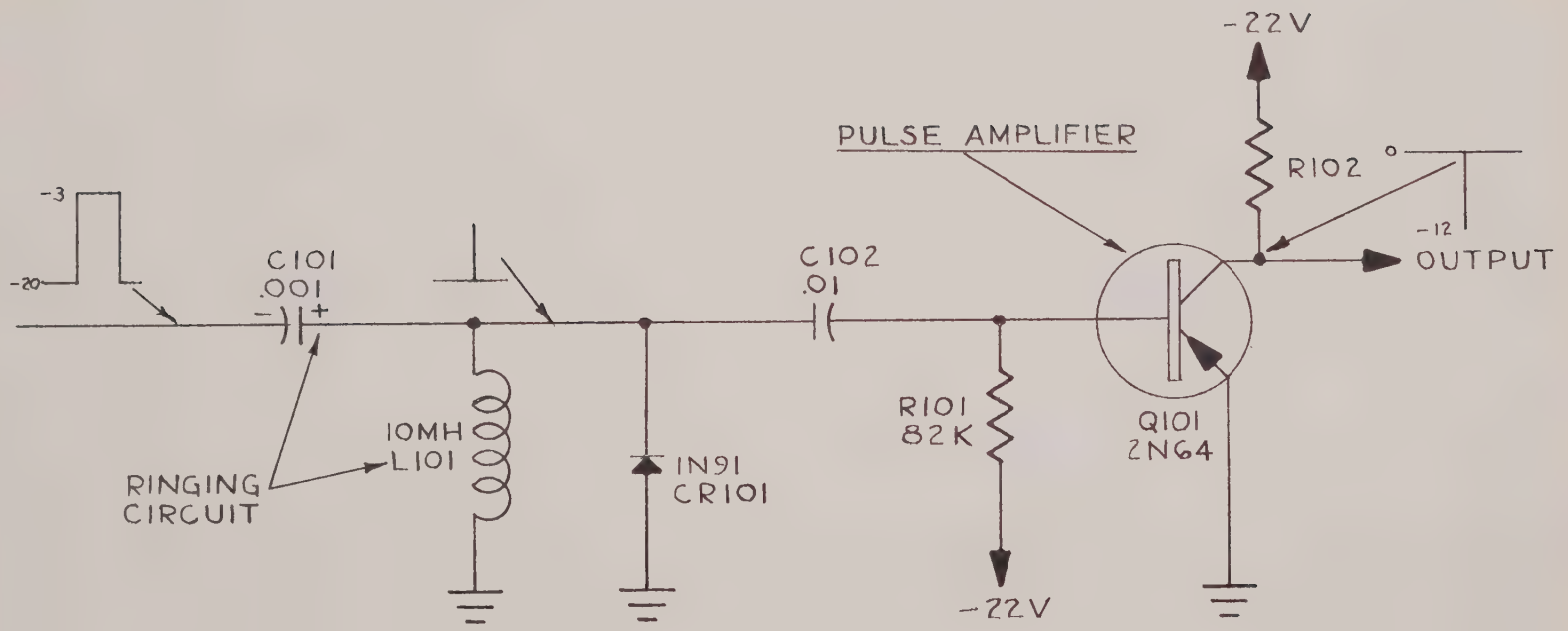

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FIGURE 2-22 RINGING CIRCUIT AND PULSE AMPLIFIER

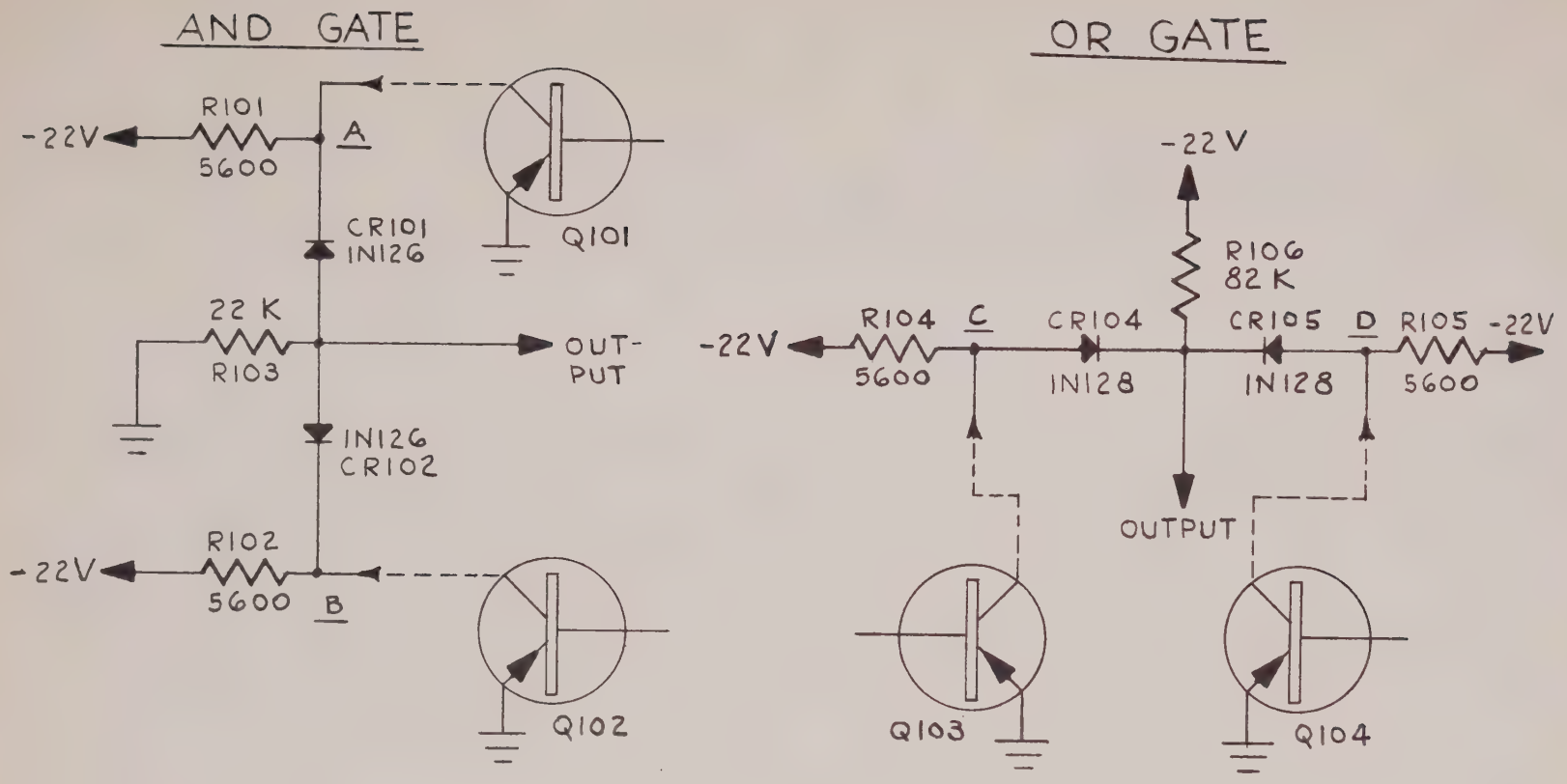


FIGURE 2-23 GATE CIRCUITS

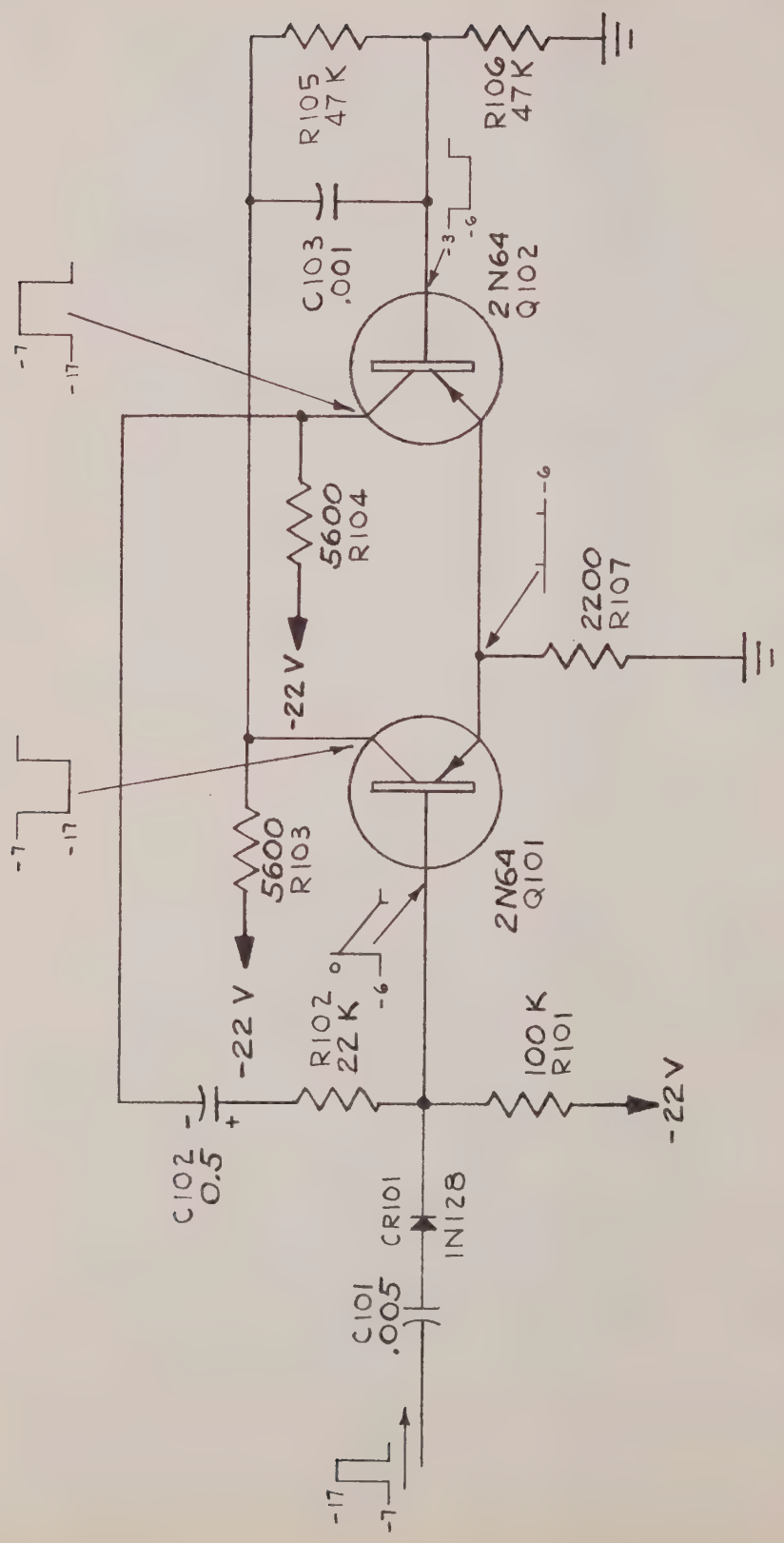
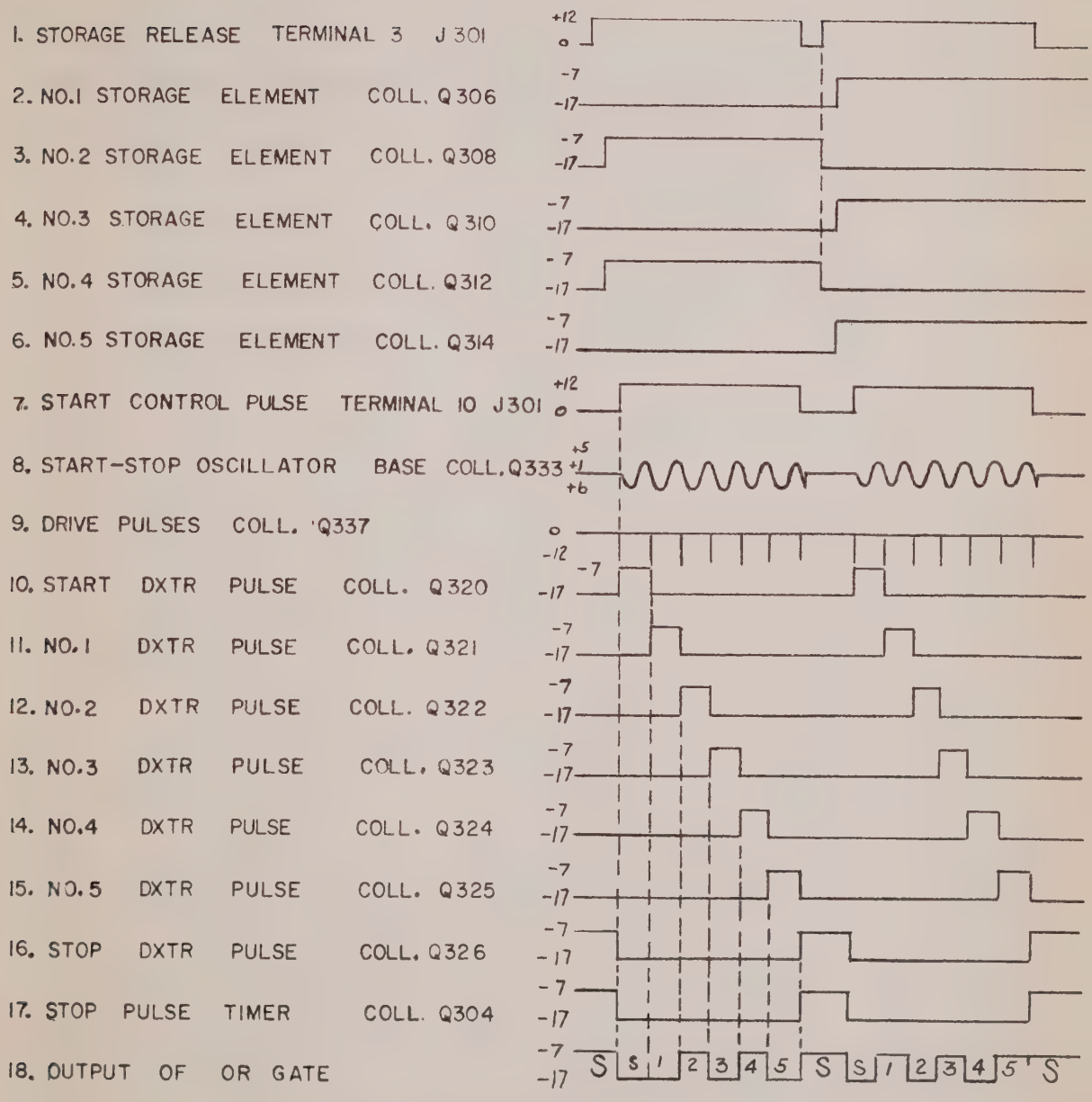


FIGURE 2-24 UNIVIBRATOR

FIGURE 2-25

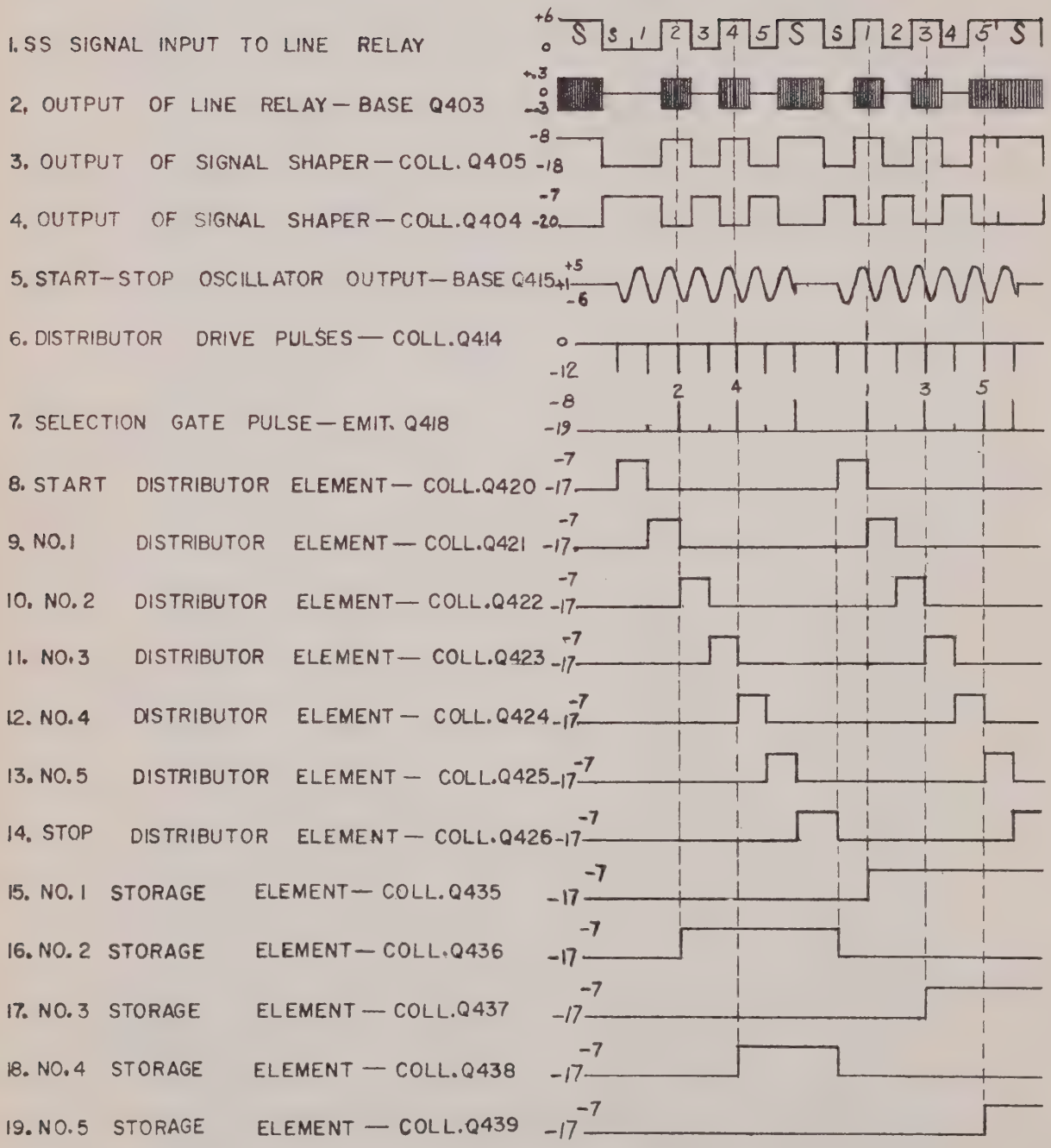
TIMING DIAGRAM OF
TRANSMITTING DISTRIBUTOR



NOTE: THIS DIAGRAM IS FOR TIMING PURPOSES ONLY AND DOES NOT REPRESENT ACTUAL WAVEFORMS

FIGURE 2-26

TIMING DIAGRAM OF
RECEIVING DISTRIBUTOR


1. SS SIGNAL INPUT TO LINE RELAY
+6
0
S S 1 2 3 4 5 S S 1 2 3 4 5 S
2. OUTPUT OF LINE RELAY — BASE Q403
+3
0
-3
3. OUTPUT OF SIGNAL SHAPER — COLL. Q405
-8
-18
4. OUTPUT OF SIGNAL SHAPER — COLL. Q404
-7
-20
5. START-STOP OSCILLATOR OUTPUT — BASE Q415
+5
+1
-6
6. DISTRIBUTOR DRIVE PULSES — COLL. Q414
0
-12
7. SELECTION GATE PULSE — EMIT. Q418
2 4 1 3 5
-8
-19
8. START DISTRIBUTOR ELEMENT — COLL. Q420
-7
-17
9. NO. 1 DISTRIBUTOR ELEMENT — COLL. Q421
10. NO. 2 DISTRIBUTOR ELEMENT — COLL. Q422
11. NO. 3 DISTRIBUTOR ELEMENT — COLL. Q423
12. NO. 4 DISTRIBUTOR ELEMENT — COLL. Q424
13. NO. 5 DISTRIBUTOR ELEMENT — COLL. Q425
14. STOP DISTRIBUTOR ELEMENT — COLL. Q426
15. NO. 1 STORAGE ELEMENT — COLL. Q435
16. NO. 2 STORAGE ELEMENT — COLL. Q436
17. NO. 3 STORAGE ELEMENT — COLL. Q437
18. NO. 4 STORAGE ELEMENT — COLL. Q438
19. NO. 5 STORAGE ELEMENT — COLL. Q439

NOTE: THIS DIAGRAM IS FOR TIMING PURPOSES ONLY AND DOES NOT REPRESENT ACTUAL WAVEFORMS.

1. 750 WPM START STOP SIGNAL
(FOR REFERENCE)

2. INPUT TO NO. 1 STORAGE GATES OF A,
UNITS—TERMINAL NO. 1 J 801

3. INPUT TO NO. 2 STORAGE GATES OF
UNITS—TERMINAL NO. 2 J 801

4. INPUT TO NO. 3 STORAGE GATES OF
UNITS—TERMINAL NO. 3 J 801

5. INPUT TO NO. 4 STORAGE GATES OF
UNITS—TERMINAL NO. 4 J 801

6. INPUT TO NO. 5 STORAGE GATES OF
UNITS—TERMINAL NO. 5 J 801

7. INPUT TO NO. 6 STORAGE GATES A,B
(USED FOR FIGURES ONLY) TERMINAL N

8. PULSE FOR "A" PRINTING DISTRIBUTOR
TERMINAL NO. 20 J 801

9. "A" TRANSFER PULSES (PUT THE 1ST
CHARACTERS INTO "A" STORAGE) TERMIN

10. 1ST ELEMENT OF "A" PRINTING DISTR
COLL. Q 820

11. 2ND ELEMENT OF "A" PRINTING DISTR
COLL. Q 821

12. PRINTING PERIODS FOR "A" UNIT

13. PULSE FOR "B" PRINTING DISTRI

14. "B" TRANSFER PULSES (PUT THE 2ND
CHARACTERS INTO "B" STORAGE)

15. 1ST ELEMENT OF "B" PRINTING DIST

16. 2ND ELEMENT OF "B" PRINTING DIST

17. PRINTING PERIODS FOR "B" UNIT

18. PULSE FOR "C" PRINTING DISTRIBU

19. "C" TRANSFER PULSES (PUT 3RD &
CHARACTERS INTO "C" STORAGE)

20. 1ST ELEMENT OF "C" PRINTING DIST

21 2ND ELEMENT OF "C" PRINTING DIST

22. PRINTING PERIODS FOR "C" UNIT

23. CHARACTER INDEX PULSES AND CH
ON TYPE WHEEL — TERMINAL 27 J 8

* INDICATES PULSES COMING FROM
CONTROL UNIT

** INDICATES PULSES COMING FROM
RECEIVING DISTRIBUTOR UNIT

THESE WAVEFORMS ARE FOR TIMIN
ONLY AND MAY NOT REPRESENT T
WAVEFORMS IN THE CIRCUITS

Figure 2-27

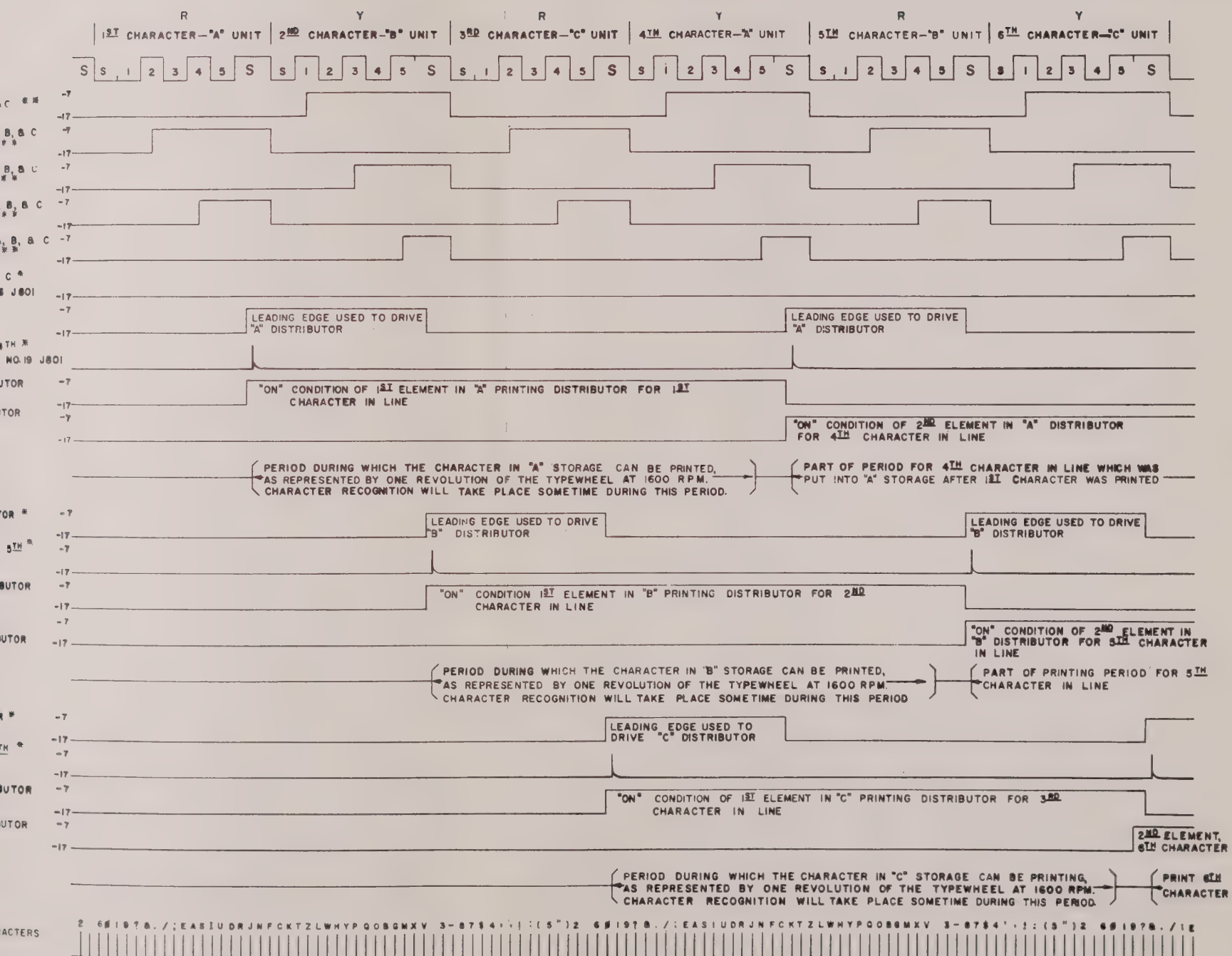

R
1ST CHARACTER—"A" UNIT
Y
2ND CHARACTER—"B" UNIT
R
3RD CHARACTER—"C" UNIT
Y
4TH CHARACTER—"A" UNIT
R
5TH CHARACTER—"B" UNIT
Y
6TH CHARACTER—"C" UNIT
S S 1 2 3 4 5 S
-7
-17
LEADING EDGE USED TO DRIVE "A" DISTRIBUTOR
LEADING EDGE USED TO DRIVE "A" DISTRIBUTOR
"ON" CONDITION OF 1ST ELEMENT IN "A" PRINTING DISTRIBUTOR FOR 1ST CHARACTER IN LINE
"ON" CONDITION OF 2ND ELEMENT IN "A" DISTRIBUTOR FOR 4TH CHARACTER IN LINE
PERIOD DURING WHICH THE CHARACTER IN "A" STORAGE CAN BE PRINTED, AS REPRESENTED BY ONE REVOLUTION OF THE TYPEWHEEL AT 1600 RPM. CHARACTER RECOGNITION WILL TAKE PLACE SOMETIME DURING THIS PERIOD.
PART OF PERIOD FOR 4TH CHARACTER IN LINE WHICH WAS PUT INTO "A" STORAGE AFTER 1ST CHARACTER WAS PRINTED
LEADING EDGE USED TO DRIVE "B" DISTRIBUTOR
LEADING EDGE USED TO DRIVE "B" DISTRIBUTOR
"ON" CONDITION 1ST ELEMENT IN "B" PRINTING DISTRIBUTOR FOR 2ND CHARACTER IN LINE
"ON" CONDITION OF 2ND ELEMENT IN "B" DISTRIBUTOR FOR 5TH CHARACTER IN LINE
PERIOD DURING WHICH THE CHARACTER IN "B" STORAGE CAN BE PRINTED, AS REPRESENTED BY ONE REVOLUTION OF THE TYPEWHEEL AT 1600 RPM. CHARACTER RECOGNITION WILL TAKE PLACE SOMETIME DURING THIS PERIOD
PART OF PRINTING PERIOD FOR 5TH CHARACTER IN LINE
LEADING EDGE USED TO DRIVE "C" DISTRIBUTOR
"ON" CONDITION OF 1ST ELEMENT IN "C" PRINTING DISTRIBUTOR FOR 3RD CHARACTER IN LINE
2ND ELEMENT, 6TH CHARACTER
PERIOD DURING WHICH THE CHARACTER IN "C" STORAGE CAN BE PRINTING, AS REPRESENTED BY ONE REVOLUTION OF THE TYPEWHEEL AT 1600 RPM. CHARACTER RECOGNITION WILL TAKE PLACE SOMETIME DURING THIS PERIOD.
PRINT 6TH CHARACTER

FIGURE 2-27—TIMING DIAGRAM OF STORAGE AND CHARACTER RECOGNITION UNITS A, B, & C

Figure 2-28

1. 750 WPM START-STOP SIGNAL INPUT (FOR REFERENCE)
2. STOP PULSE FROM RECEIVING DISTRIBUTOR— TERMINAL 19 J601
3. OUTPUT OF TRANSFER PULSE GENERATOR
4. OUTPUT OF "A" DISTRIBUTOR ELEMENT— COLL. Q624
5. "A" TRANSFER PULSE— EMIT. Q627
6. OUTPUT OF "B" DISTRIBUTOR ELEMENT— COLL. Q625
7. "B" TRANSFER PULSE — EMIT. Q628
8. OUTPUT OF "C" DISTRIBUTOR ELEMENT — COLL. Q626
9. "C" TRANSFER PULSE — EMIT. Q629
10. OUTPUT OF SPACE RECOGNITION GATE
11. OUTPUT OF FIGURES RECOGNITION GATE
12. OUTPUT OF FIGURES STORAGE FLIP-FLOP COLL. Q607
13. OUTPUT OF LETTERS RECOGNITION GATE
14. OUTPUT OF CARRIAGE RETURN RECOGNITION GATE
15. OUTPUT O- CARRIAGE RETURN DELAY UNIVIBATOR— COLL. Q637
16. CARRIAGE RETURN PULSE— COLL. Q 641
17. OUTPUT OF AUTOMATIC CARRIAGE RETURN— LINE FEED DELETE UNIVIBRATOR— COLL. Q639
18. OUTPUT OF LINE FEED RECOGNITION GATE
19. DOUBLE LINE FEED PULSE GENERATOR— COLL. Q 632
20. DOUBLE LINE FEED PULSE GENERATOR— COLL. Q 631
21. RECHARGE PULSE GENERATOR— COLL. Q634

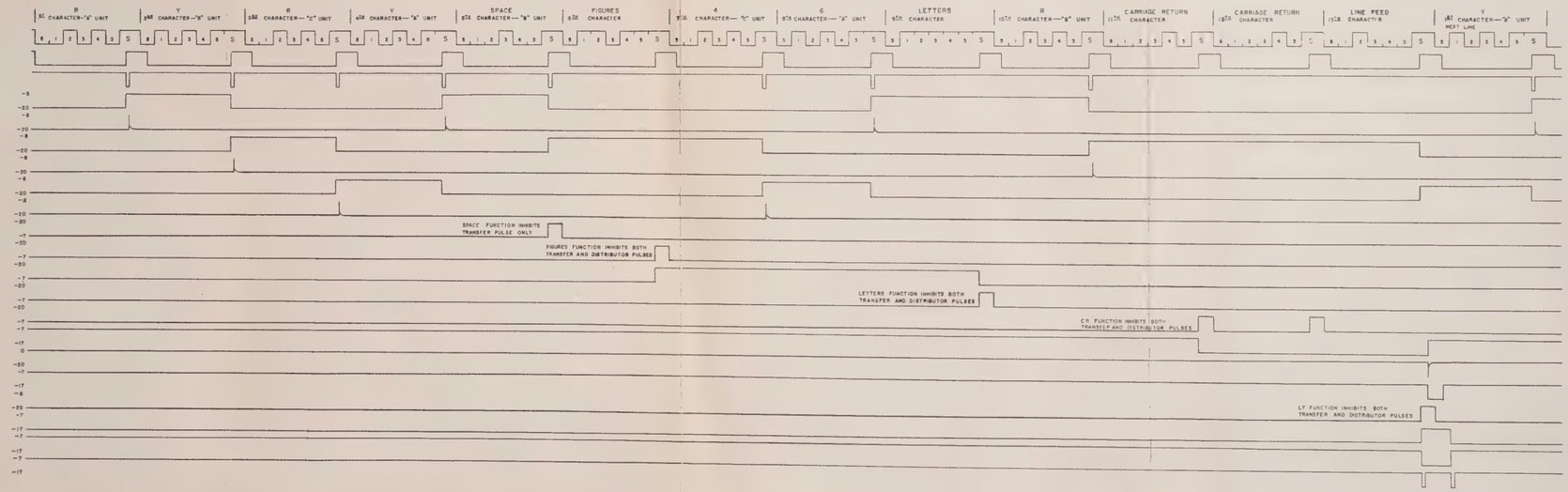


FIGURE 2-28 -TIMING DIAGRAM OF CONTROL UNIT

1 CHARACTER INDEX PULSES –

2 SET ZERO –

3 FUNCTION INDEX PULSES –

4 1ST STAGE BINARY COUNTER

5. 1ST STAGE BINARY COUNTER

6 2ND STAGE BINARY COUNTER

7 2ND STAGE BINARY COUNTE

8 3RD STAGE BINARY COUNTE

9. 3RD STAGE BINARY COUNTE

10 4TH STAGE BINARY COUNTE

11. 4TH STAGE BINARY COUNTE

12. 5TH STAGE BINARY COUNTE

13 5TH STAGE BINARY COUNTE

14. 6TH STAGE BINARY COUNTER

15. 6TH STAGE BINARY COUNTE

16. FEEDBACK PULSE FROM SP

THESE WAVEFORMS ARE FO
ONLY AND MAY NOT REPRE
WAVEFORMS IN THE CIRCU

Figure 2-29

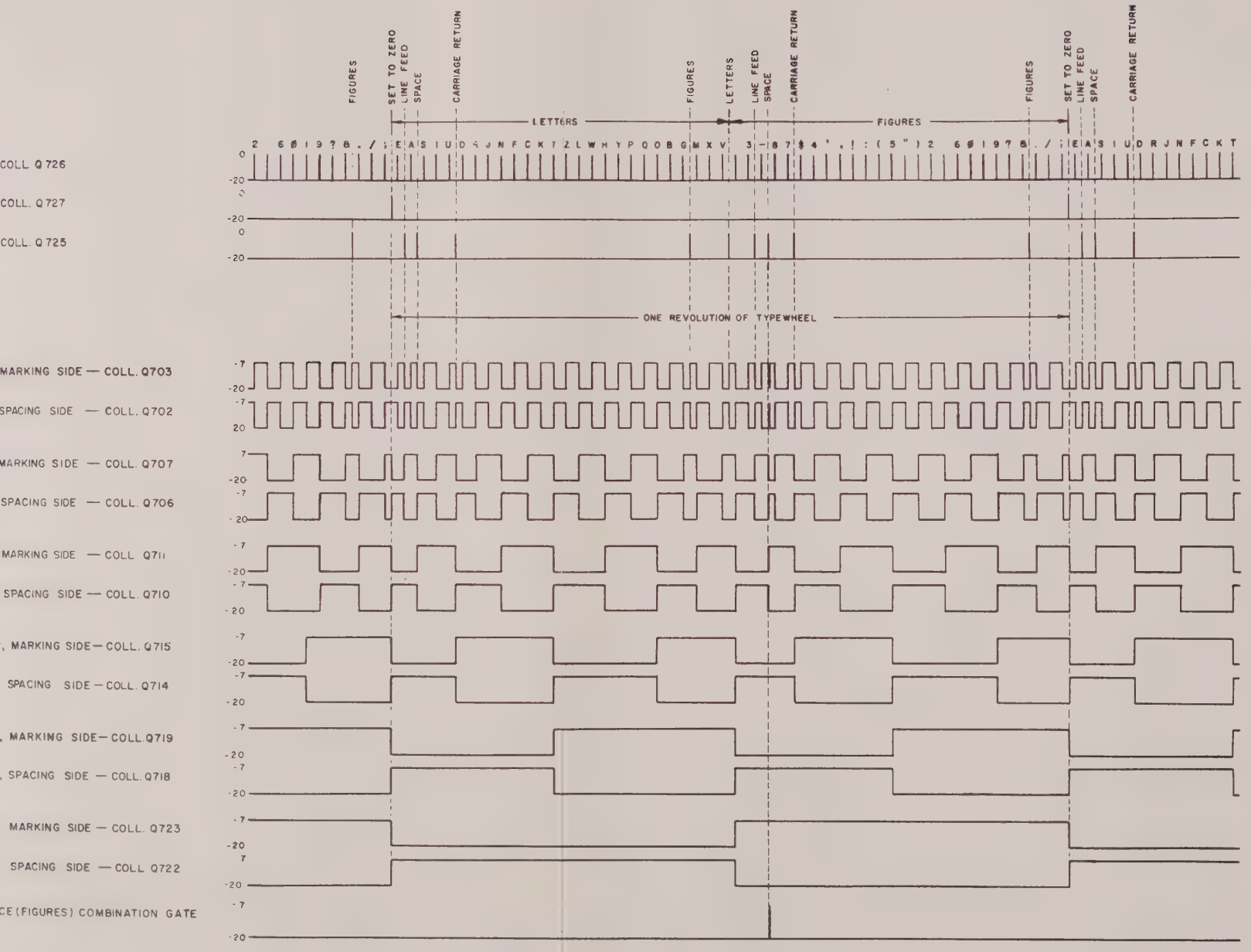


FIGURE 2-29—TIMING DIAGRAM OF BINARY COUNTER UNIT

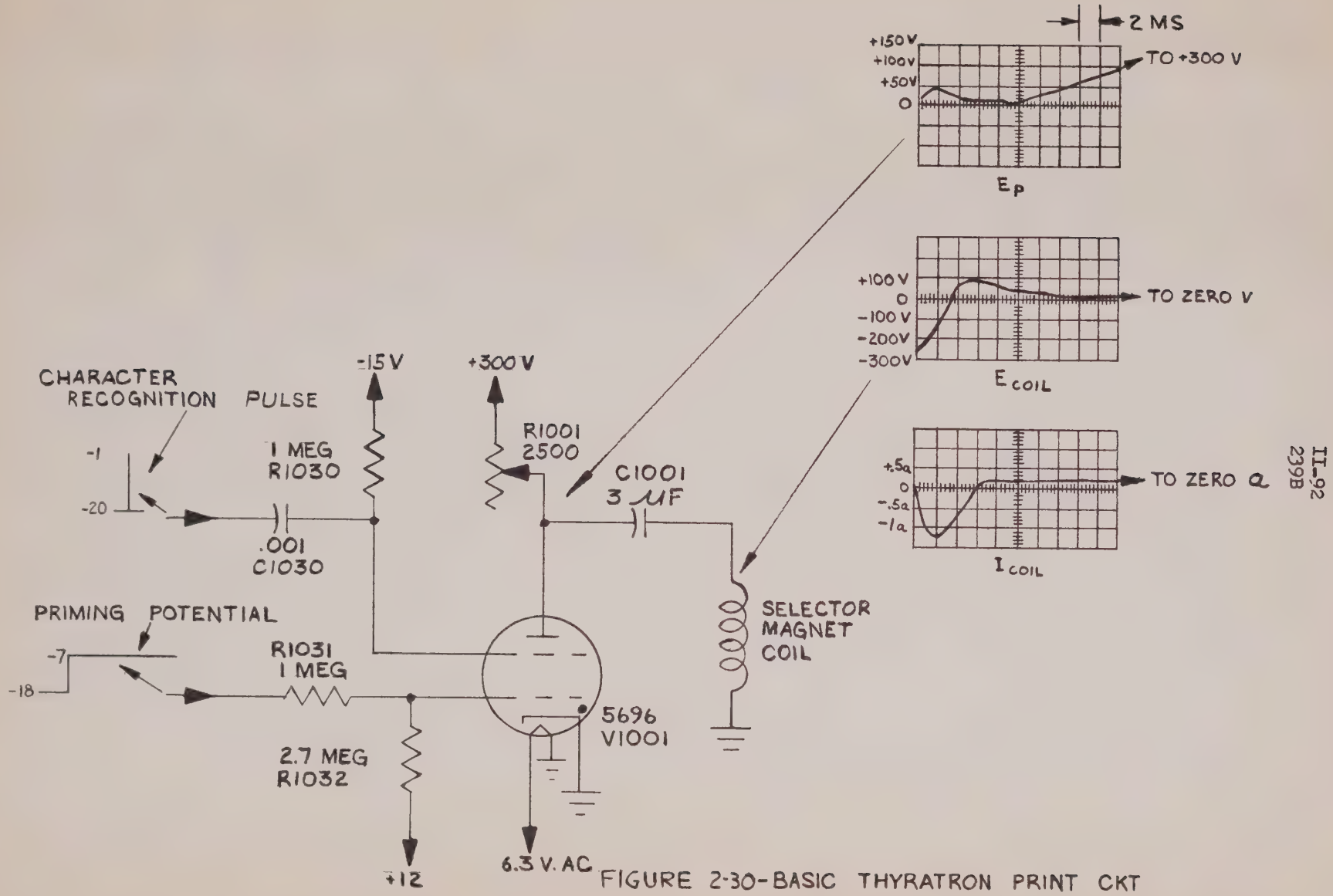


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FIGURE 2-30-BASIC THYRATRON PRINT CKT

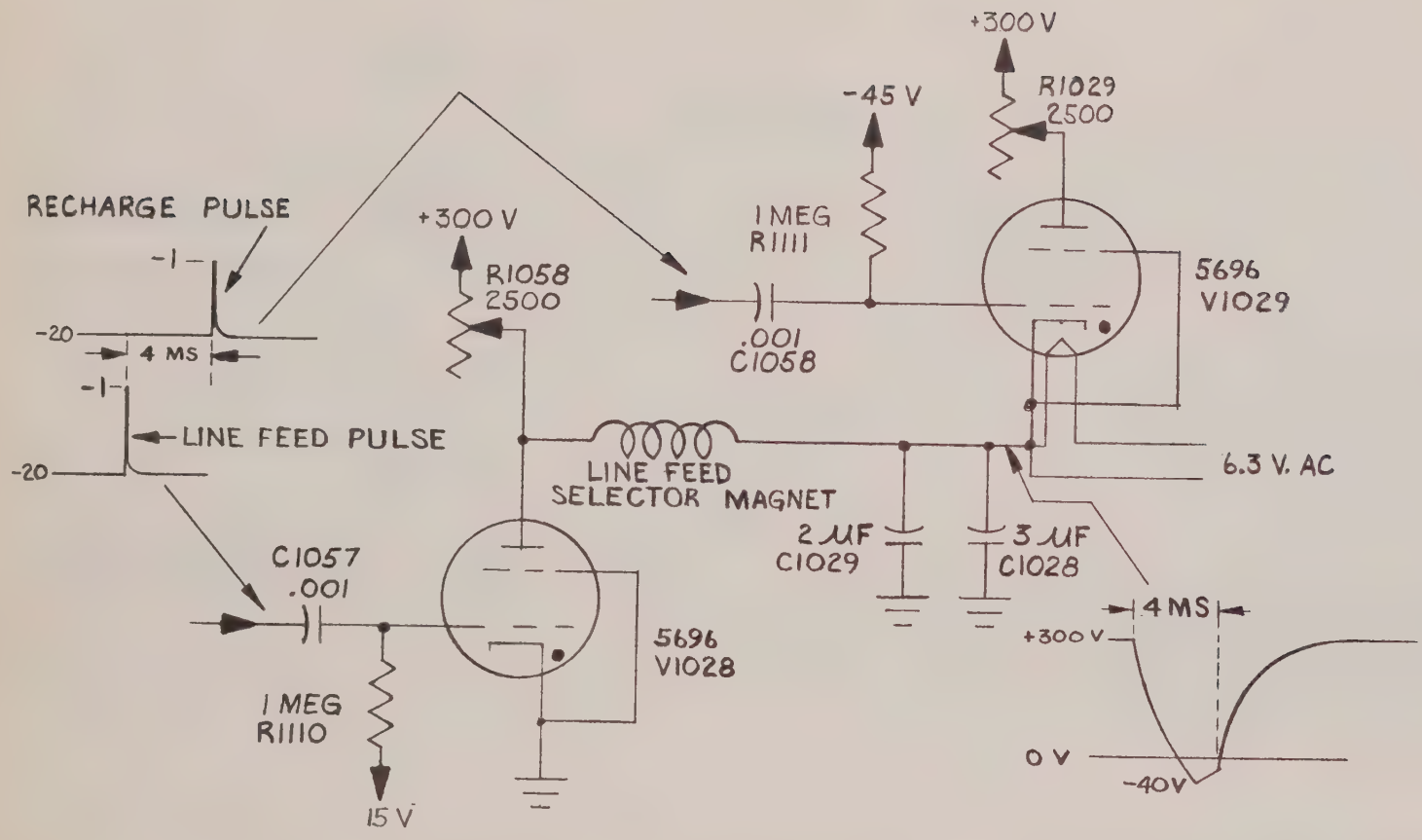


FIGURE 2-31 — LINE FEED CIRCUIT

F. ELECTRONIC CONTROL SYSTEM CABINET

1. DETAILED DESCRIPTION

a. The High Speed Page Printer Control Cabinet is a welded heavily reinforced aluminum enclosure, approximately 36" high, 21" wide and 25" deep.

b. The contents of the cabinet are:

(1) Top row . . . . . Power Supply

(2) Middle row. . . . . 3 Print Circuit Units

(3) Bottom row. . . . . Transmitting Distributor Unit
Receiving Distributor Unit
3 Storage and Character Recognition Units
Control Unit
Binary Counter Unit

c. A sliding drawer arrangement to facilitate maintenance is provided for each of the units. These may all be withdrawn for test without interrupting the circuit. This is made possible in the case of the power supply by the allowance of sufficient cable slack to enable the drawer to travel its full length. In the case of the other ten drawers a bellows cable performs the same function.

(1) The bellows cable assemblies to the 3 print circuit drawers terminate in a horizontal interconnecting block at the rear of the cabinet. The cable assemblies to the seven lower drawers terminate in connectors mounted on a horizontally hinged door which may be released and set down for inspection and test purposes.

(2) Cam throw drawer stops are provided to stop the travel of each unit at its test position, and to permit its removal from the box when required.

(3) Major units are held locked in operating position by captive type screws.

d. A hinged rear door opens for access to terminal boards.

2. THEORY OF OPERATION

a. Since the cabinet utilizes only simple passive mechanisms, no special description of theory of operation is required.

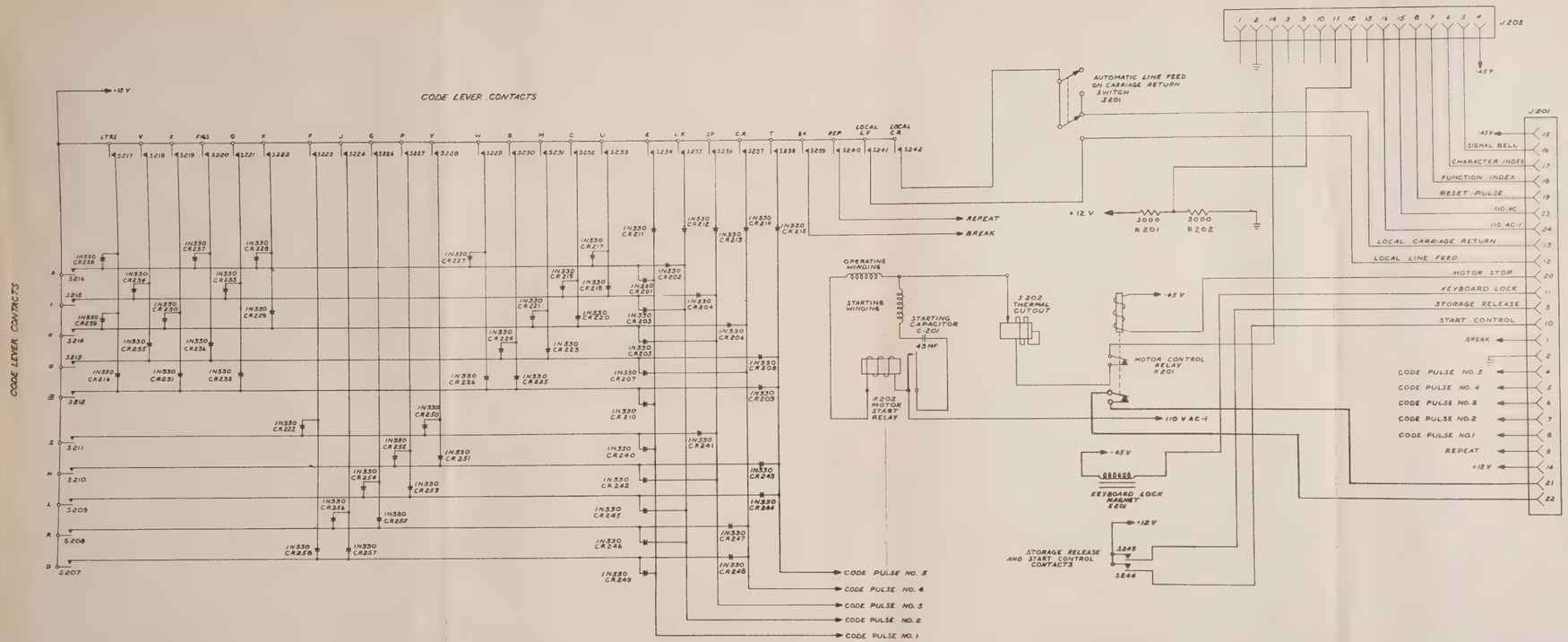
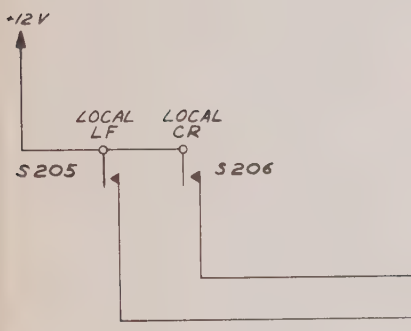
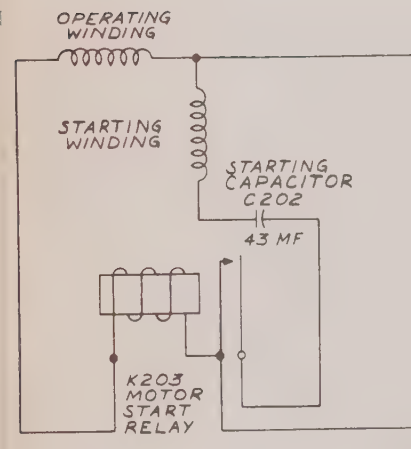

CODE LEVER CONTACTS
+12 V
LTRS V X FIGS O K F J G P Y W B M C U E L.F. SP C.R. T BK REP LOCAL L.F. LOCAL C.R.
S217 S218 S219 S220 S221 S222 S223 S224 S226 S227 S228 S229 S230 S251 S252 S233 S234 S235 S236 S237 S238 S239 S240 S241 S242
A I H O M S N L R D
S216 S215 S214 S213 S212 S211 S210 S209 S208 S207
IN330 CR236 IN330 CR237 IN330 CR228 IN330 CR227 IN330 CR217 IN330 CR211 IN330 CR212 IN330 CR213 IN330 CR214 IN330 CR215
IN330 CR234 IN330 CR230 IN330 CR233 IN330 CR219 IN330 CR218 IN330 CR202
IN330 CR239 IN330 CR229 IN330 CR221 IN330 CR220 IN330 CR201 IN330 CR204
IN330 CR255 IN330 CR256 IN330 CR224 IN330 CR223 IN330 CR203 IN330 CR206
IN330 CR216 IN330 CR231 IN330 CR232 IN330 CR226 IN330 CR225 IN330 CR207 IN330 CR208
IN330 CR250 IN330 CR209
IN330 CR222 IN330 CR210
IN330 CR252 IN330 CR251 IN330 CR240 IN330 CR241
IN330 CR254 IN330 CR253 IN330 CR242 IN330 CR243
IN330 CR244 IN330 CR257 IN330 CR245 IN330 CR244
IN330 CR258 IN330 CR257 IN330 CR246 IN330 CR247
IN330 CR249 IN330 CR248
CODE PULSE NO. 5
CODE PULSE NO. 4
CODE PULSE NO. 3
CODE PULSE NO. 2
CODE PULSE NO. 1
REPEAT
BREAK
AUTOMATIC LINE FEED ON CARRIAGE RETURN SWITCH S201
J202
1 2 14 3 9 10 11 12 13 14 15 8 7 6 5 4
+45 V
J201
-45V SIGNAL BELL CHARACTER INDEX FUNCTION INDEX RESET PULSE 110 AC 110 AC-1 LOCAL CARRIAGE RETURN LOCAL LINE FEED MOTOR STOP KEYBOARD LOCK STORAGE RELEASE START CONTROL BREAK CODE PULSE NO. 5 CODE PULSE NO. 4 CODE PULSE NO. 3 CODE PULSE NO. 2 CODE PULSE NO. 1 REPEAT +12 V
15 16 17 18 19 23 24 13 12 20 11 5 10 1 2 4 5 6 7 8 9 14 21 22
+12 V
3000 R201
3000 R202
OPERATING WINDING
STARTING WINDING
STARTING CAPACITOR C-201 4.5 MF
K202 MOTOR START RELAY
S202 THERMAL CUTOUT
+45 V
MOTOR CONTROL RELAY K201
110 V AC-1
-45 V
KEYBOARD LOCK MAGNET E201
+12 V
STORAGE RELEASE AND START CONTROL CONTACTS
S245
S246

FIG. 5-1
AN/FGC-36
KEYBOARD
UNIT
SCHEMATIC
DIAGRAM


+12 V
LOCAL LF
LOCAL CR
S205
S206


OPERATING WINDING
STARTING WINDING
STARTING CAPACITOR C202
43 MF
K203 MOTOR START RELAY

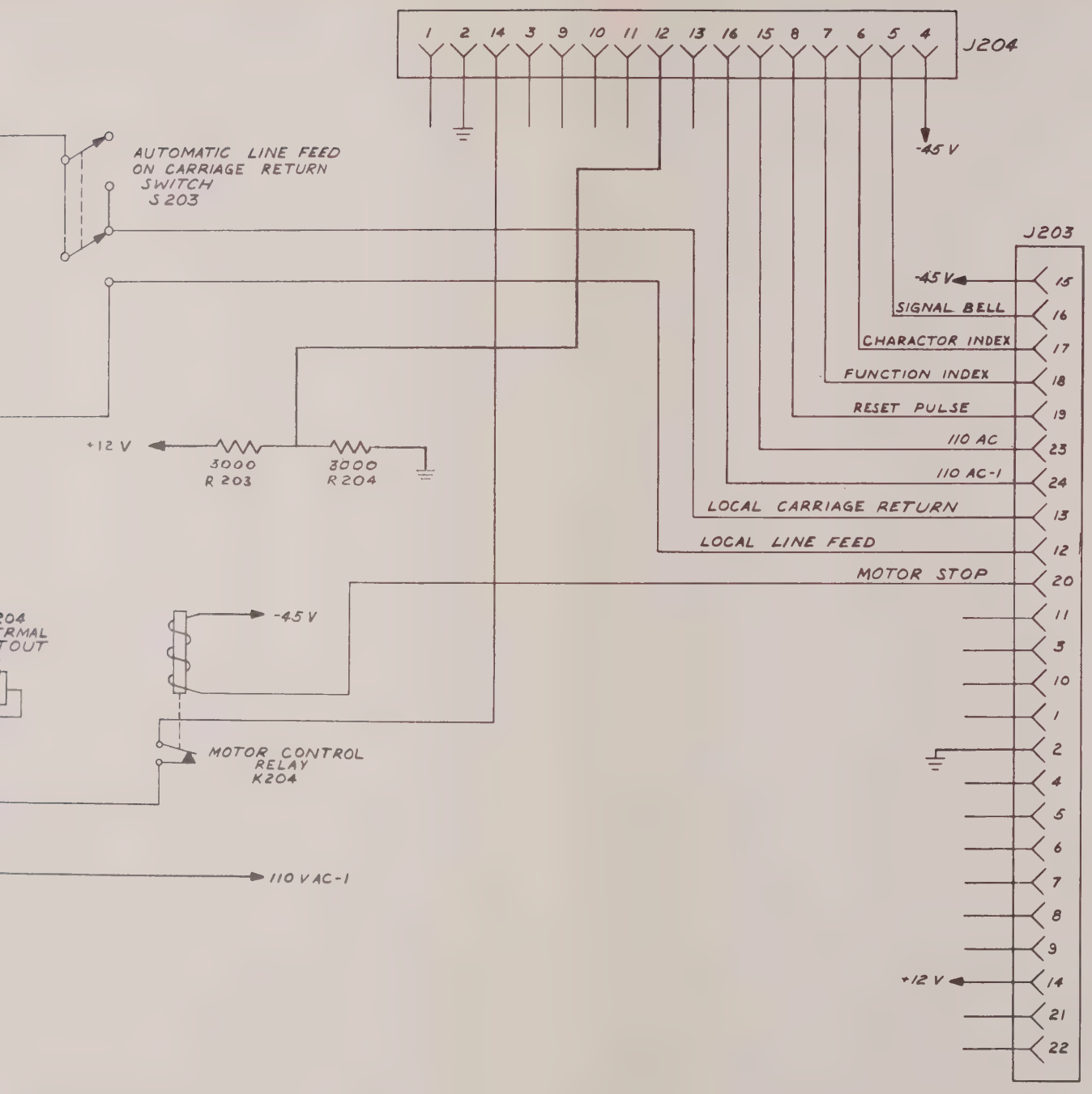
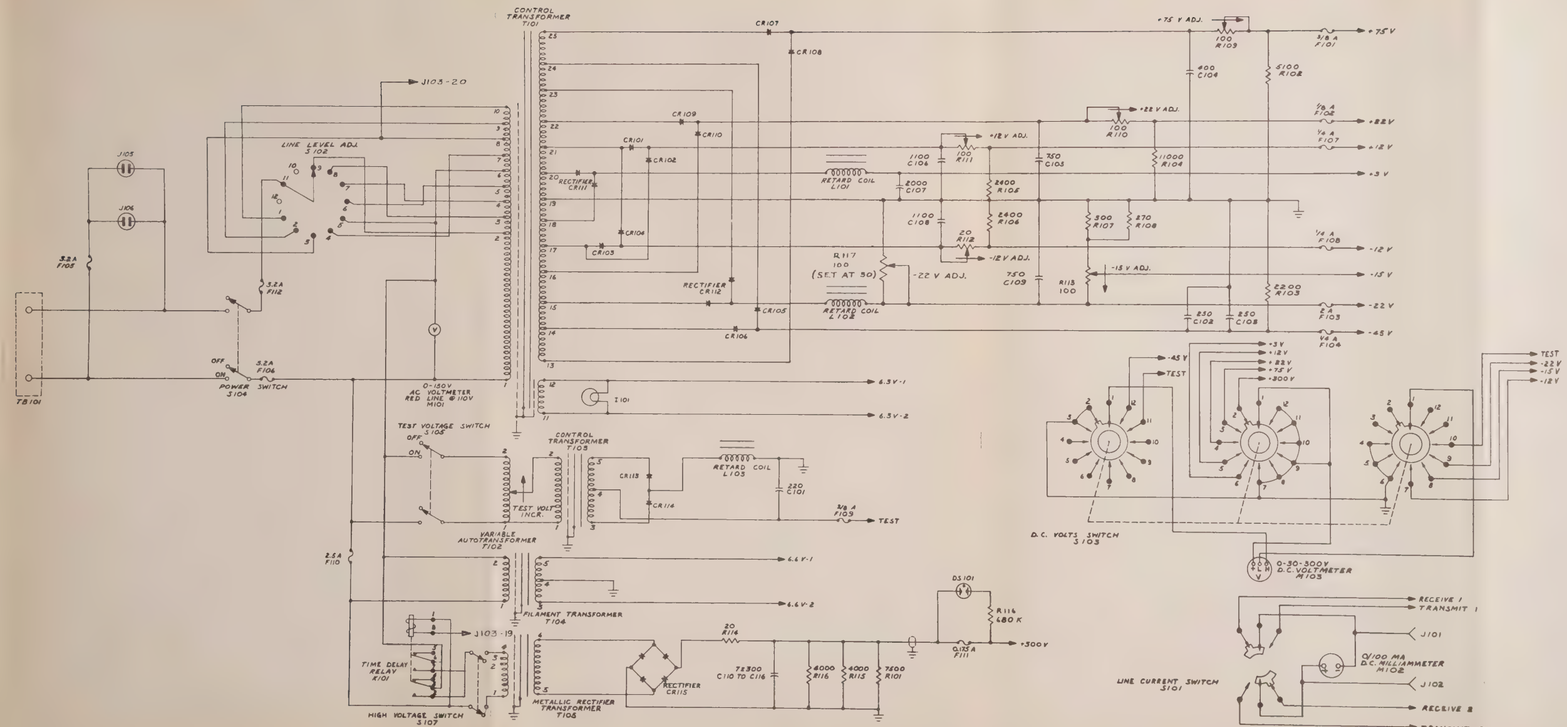


FIG. 5-2
AN/FGC-36
RECEIVING
ONLY BASE
SCHEMATIC
DIAGRAM



NOTES:
1. RESISTANCE VALUES IN OHMS UNLESS SUFFIXED WITH "K" FOR KILOHMS
2. CAPACITANCE VALUES IN MICRO-FARADS

FIG. 5-3
AN/FGC-36
POWER
SUPPLY
SCHEMATIC
DIAGRAM

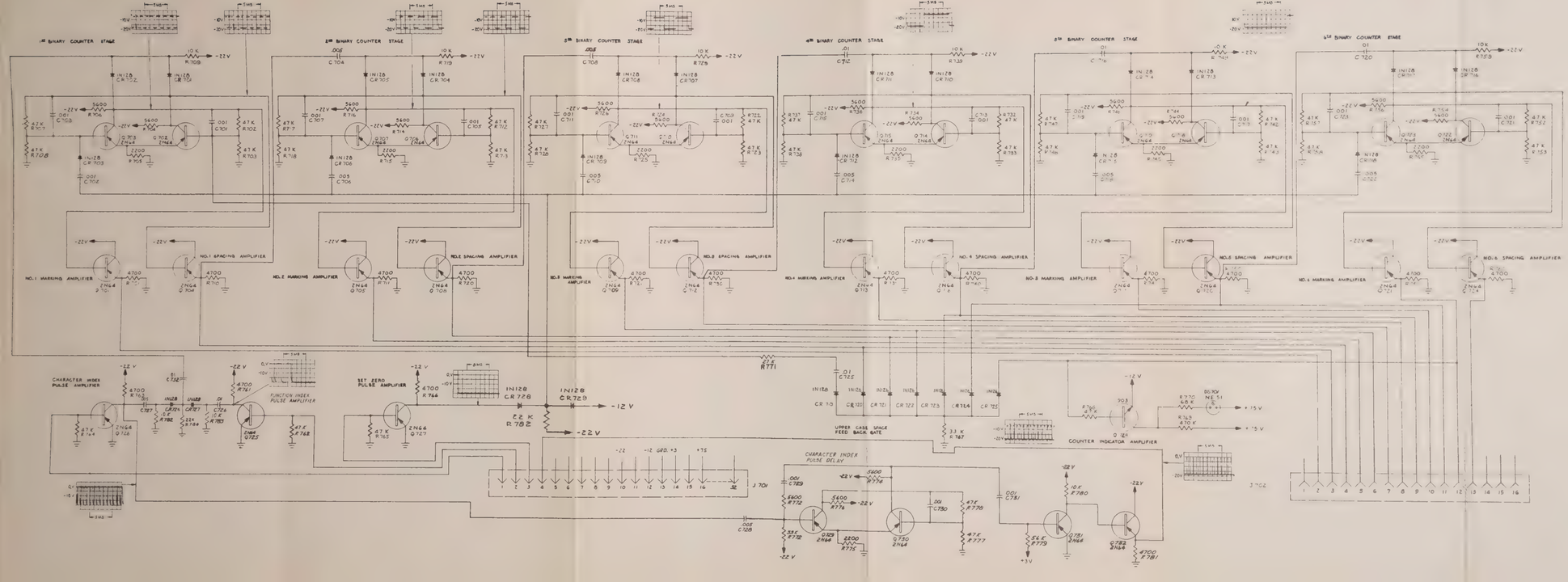
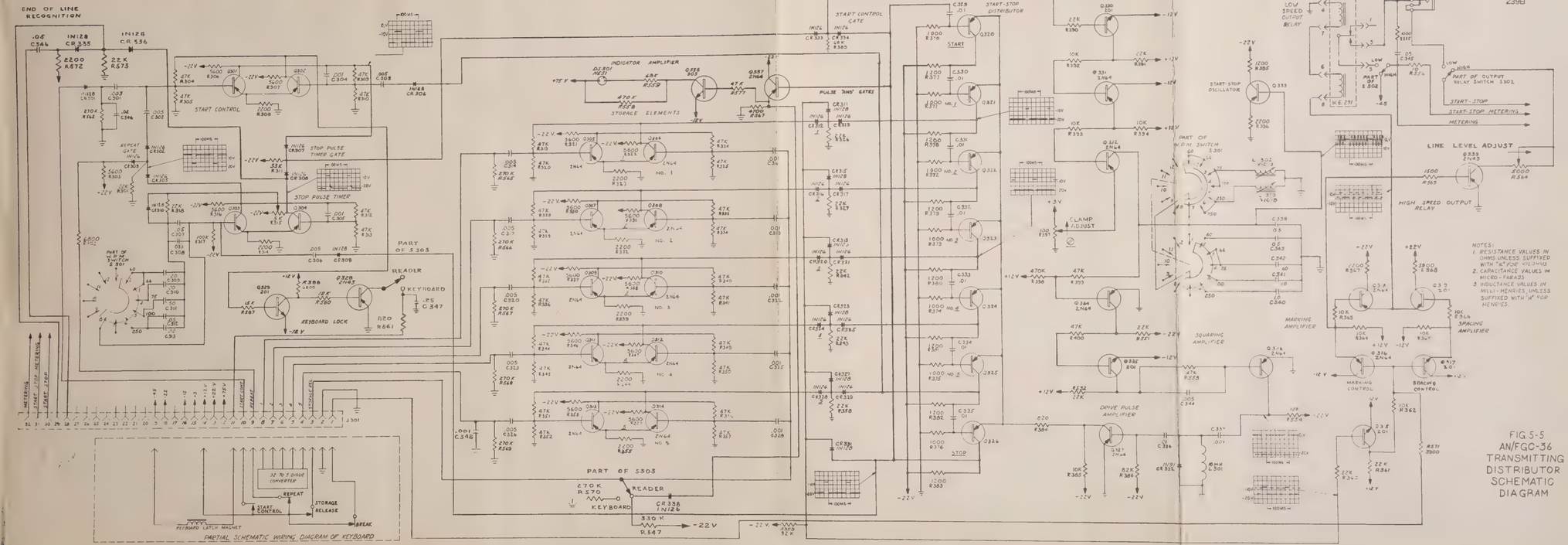
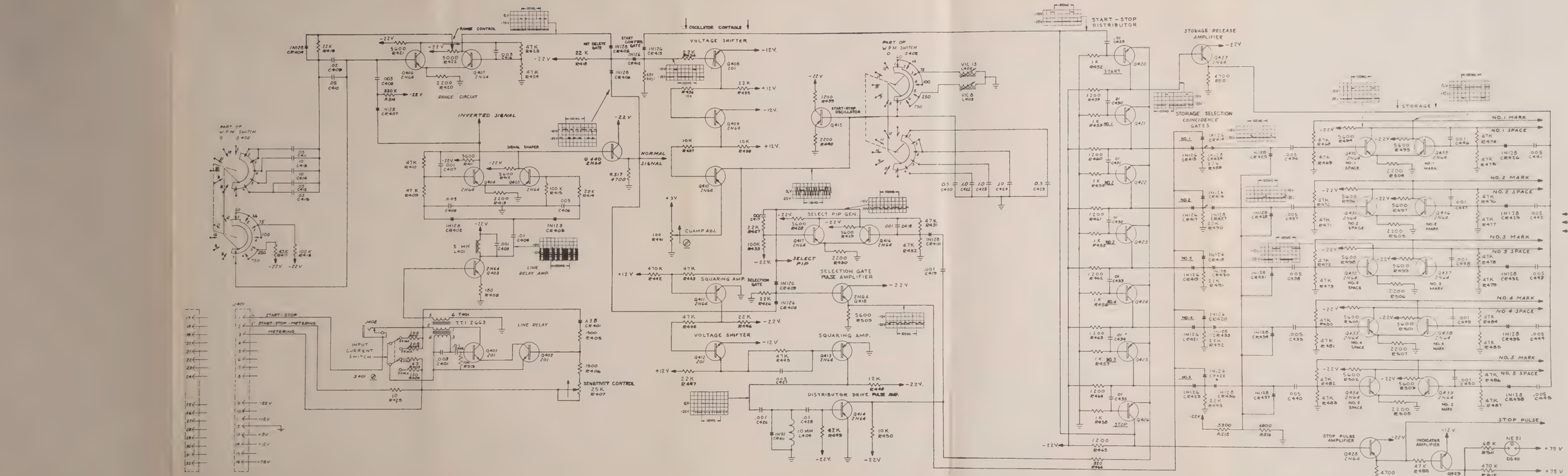


FIG 5-4
AN/FGC-36
BINARY
COUNTER
SCHEMATIC
DIAGRAM



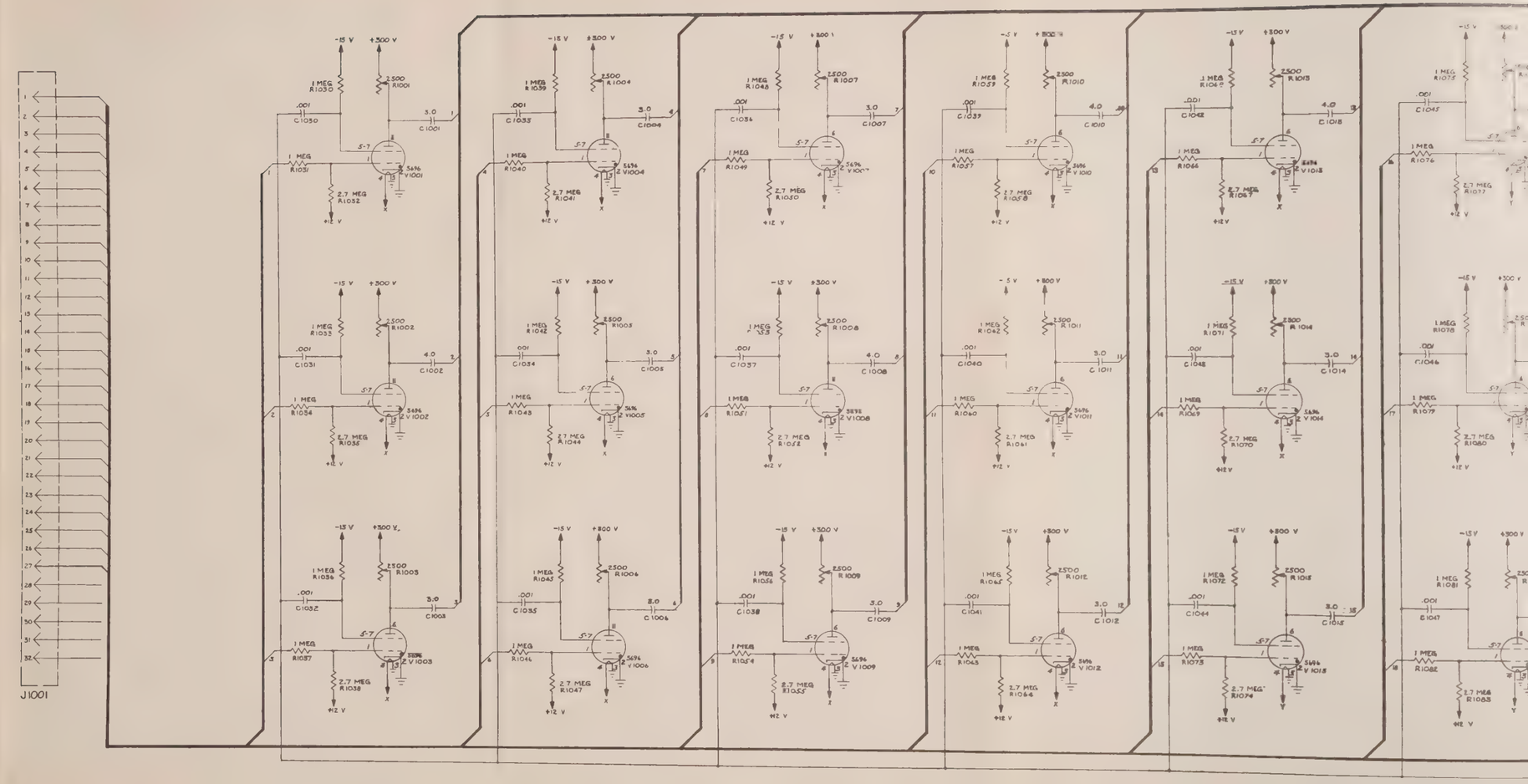
NOTES:
1. RESISTANCE VALUES IN OHMS UNLESS SUFFIXED WITH "K" FOR KILOHMS
2. CAPACITANCE VALUES IN MICRO-FARADS
3. INDUCTANCE VALUES IN MILLI-HENRIES, UNLESS SUFFIXED WITH "H" FOR HENRIES.

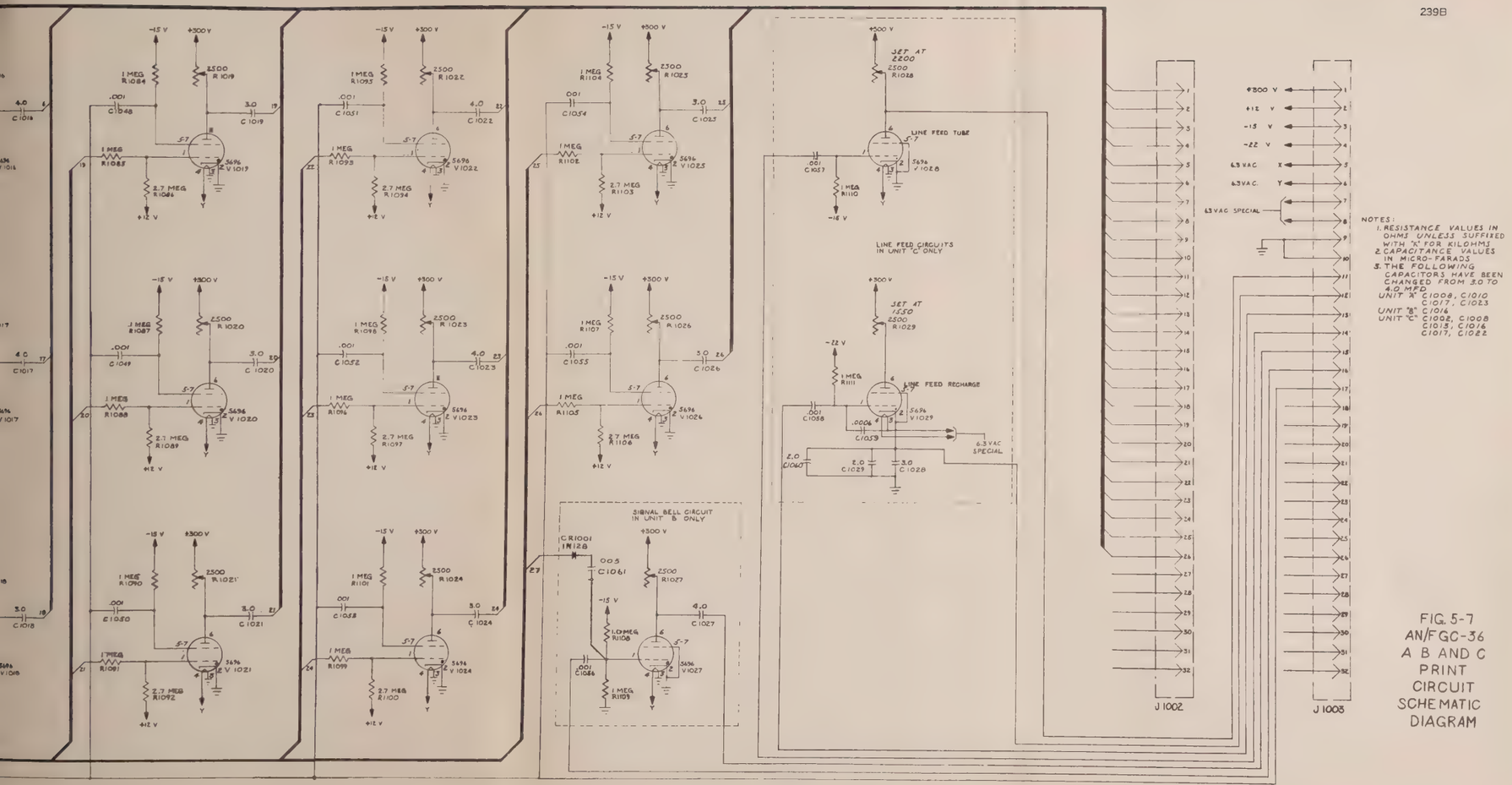
FIG. 5-5
AN/FGC-36
TRANSMITTING
DISTRIBUTOR
SCHEMATIC
DIAGRAM



NOTES
1. RESISTANCE VALUES IN OHMS UNLESS SUFFIXED WITH 'K' FOR KILOHMS
2. CAPACITANCE VALUES IN MICRO-FARADS
3. INDUCTANCE VALUES IN MILLIHENRIES UNLESS SUFFIXED WITH 'H' FOR HENRIES

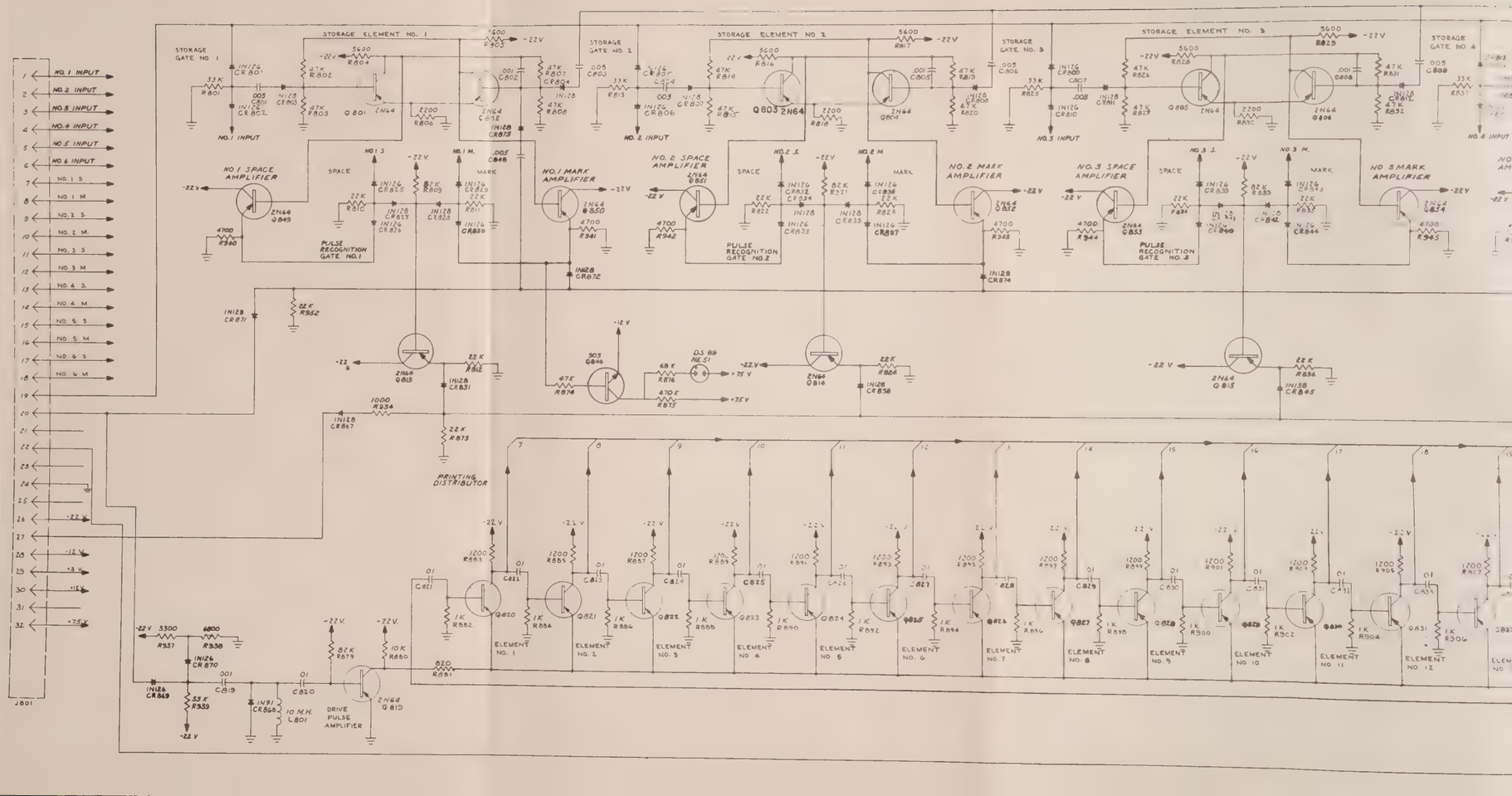
FIG. 5-6
AN/FGC-36
RECEIVING
DISTRIBUTOR
SCHEMATIC
DIAGRAM


J1001
-15 V
+300 V
1 MEG R1030
2500 R1001
.001 C1030
3.0 C1001
1 MEG R1031
2.7 MEG R1032
+12 V
5-7
5696 V1001
1 MEG R1033
2500 R1002
.001 C1031
4.0 C1002
1 MEG R1034
2.7 MEG R1035
5696 V1002
1 MEG R1036
2500 R1003
.001 C1032
3.0 C1003
1 MEG R1037
2.7 MEG R1038
5696 V1003
1 MEG R1039
2500 R1004
.001 C1033
3.0 C1004
1 MEG R1040
2.7 MEG R1041
5696 V1004
1 MEG R1042
2500 R1005
.001 C1034
3.0 C1005
1 MEG R1043
2.7 MEG R1044
5696 V1005
1 MEG R1045
2500 R1006
.001 C1035
3.0 C1006
1 MEG R1046
5696 V1006
2.7 MEG R1047
1 MEG R1048
2500 R1007
.001 C1036
3.0 C1007
1 MEG R1049
2.7 MEG R1050
5696 V1007
1 MEG R1051
2500 R1008
.001 C1037
4.0 C1008
1 MEG R1052
2.7 MEG R1053
5696 V1008
1 MEG R1054
2500 R1009
.001 C1038
3.0 C1009
1 MEG R1055
2.7 MEG R1056
5696 V1009
-5 V
+800 V
1 MEG R1057
2500 R1010
.001 C1039
4.0 C1010
1 MEG R1058
2.7 MEG R1059
5696 V1010
1 MEG R1060
2500 R1011
.001 C1040
3.0 C1011
1 MEG R1061
2.7 MEG R1062
5696 V1011
1 MEG R1063
2500 R1012
.001 C1041
3.0 C1012
1 MEG R1064
2.7 MEG R1065
5696 V1012
1 MEG R1066
2500 R1013
.001 C1042
4.0 C1013
1 MEG R1067
2.7 MEG R1068
5696 V1013
1 MEG R1069
2500 R1014
.001 C1043
3.0 C1014
1 MEG R1070
2.7 MEG R1071
5696 V1014
1 MEG R1072
2500 R1015
.001 C1044
3.0 C1015
1 MEG R1073
2.7 MEG R1074
5696 V1015
1 MEG R1075
2500 R1016
.001 C1045
1 MEG R1076
2.7 MEG R1077
1 MEG R1078
2500 R1017
.001 C1046
1 MEG R1079
2.7 MEG R1080
1 MEG R1081
2500 R1018
.001 C1047
1 MEG R1082
2.7 MEG R1083



NOTES:
1. RESISTANCE VALUES IN OHMS UNLESS SUFFIXED WITH "K" FOR KILOHMS
2. CAPACITANCE VALUES IN MICRO-FARADS
3. THE FOLLOWING CAPACITORS HAVE BEEN CHANGED FROM 3.0 TO 4.0 MFD
   UNIT 'A' C1008, C1010 C1017, C1023
   UNIT 'B' C1016
   UNIT 'C' C1002, C1008 C1013, C1016 C1017, C1022

FIG. 5-7
AN/FGC-36
A B AND C
PRINT
CIRCUIT
SCHEMATIC
DIAGRAM


NO. 1 INPUT
NO. 2 INPUT
NO. 3 INPUT
NO. 4 INPUT
NO. 5 INPUT
NO. 6 INPUT
NO. 1 S.
NO. 1 M.
NO. 2 S.
NO. 2 M.
NO. 3 S.
NO. 3 M.
NO. 4 S.
NO. 4 M.
NO. 5 S.
NO. 5 M.
NO. 6 S.
NO. 6 M.
-22 V
-12 V
+8 V
+12 V
+75 V
J801
STORAGE ELEMENT NO. 1
STORAGE ELEMENT NO. 2
STORAGE ELEMENT NO. 3
STORAGE GATE NO. 1
STORAGE GATE NO. 2
STORAGE GATE NO. 3
STORAGE GATE NO. 4
NO. 1 SPACE AMPLIFIER
NO. 1 MARK AMPLIFIER
NO. 2 SPACE AMPLIFIER
NO. 2 MARK AMPLIFIER
NO. 3 SPACE AMPLIFIER
NO. 3 MARK AMPLIFIER
PULSE RECOGNITION GATE NO. 1
PULSE RECOGNITION GATE NO. 2
PULSE RECOGNITION GATE NO. 3
PRINTING DISTRIBUTOR
DRIVE PULSE AMPLIFIER
ELEMENT NO. 1
ELEMENT NO. 2
ELEMENT NO. 3
ELEMENT NO. 4
ELEMENT NO. 5
ELEMENT NO. 6
ELEMENT NO. 7
ELEMENT NO. 8
ELEMENT NO. 9
ELEMENT NO. 10
ELEMENT NO. 11
ELEMENT NO. 12

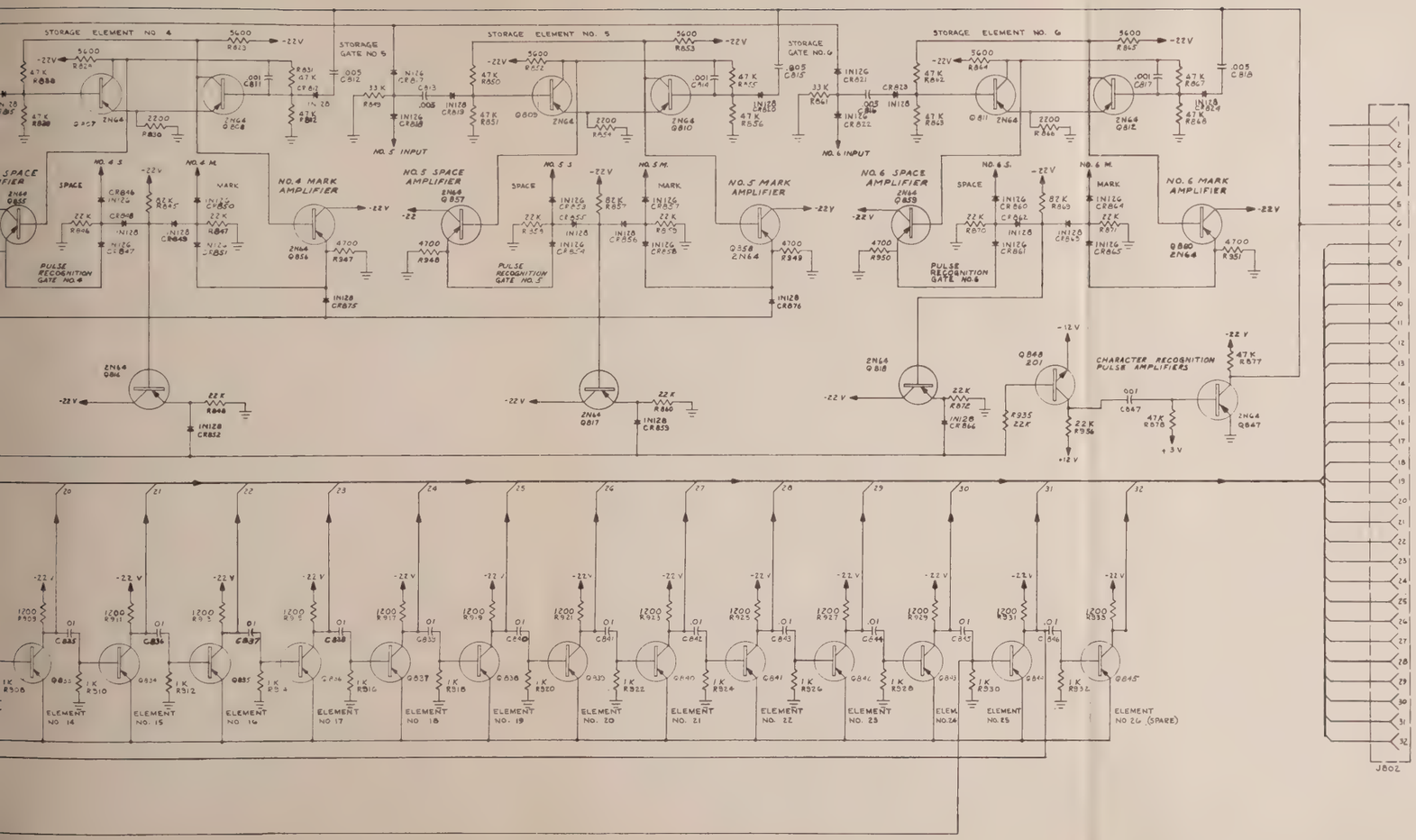
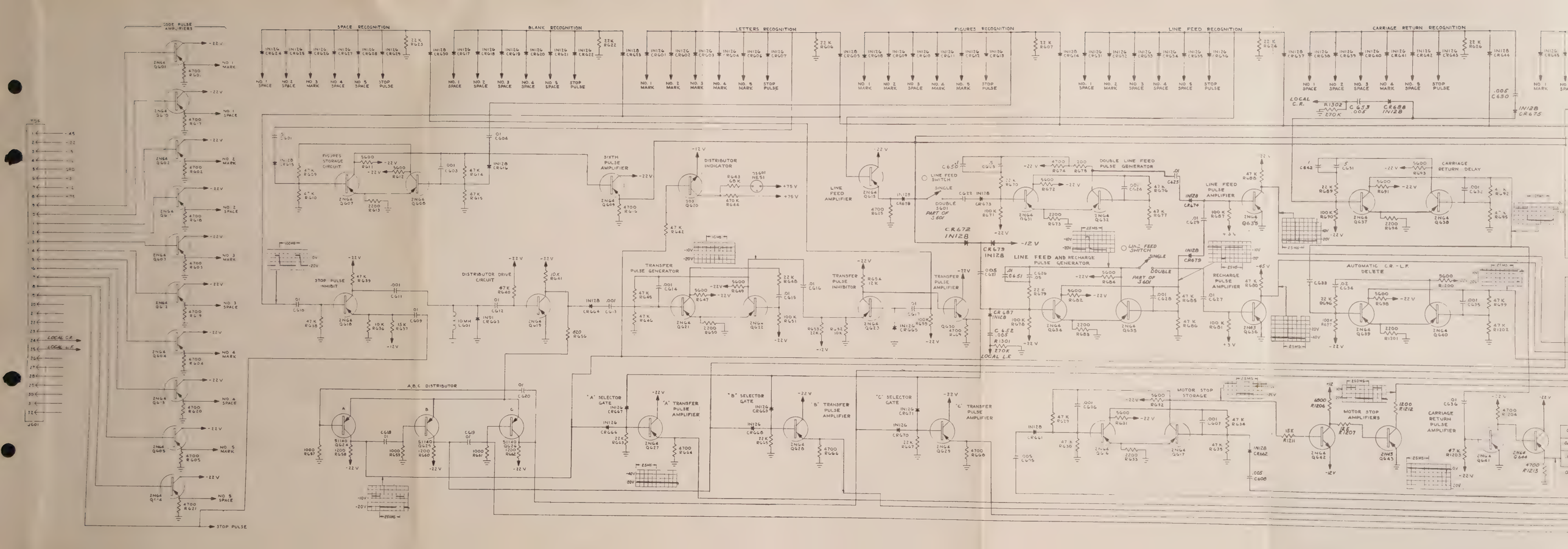


FIG. 5-8
AN/FGC-36
A, B OR C
STORAGE AND
CHARACTER
RECOGNITION
SCHEMATIC
DIAGRAM


CODE PULSE AMPLIFIERS
SPACE RECOGNITION
BLANK RECOGNITION
LETTERS RECOGNITION
FIGURES RECOGNITION
LINE FEED RECOGNITION
CARRIAGE RETURN RECOGNITION
NO. 1 SPACE
NO. 2 SPACE
NO. 3 SPACE
NO. 4 SPACE
NO. 5 SPACE
STOP PULSE
NO. 1 MARK
NO. 2 MARK
NO. 3 MARK
NO. 4 MARK
NO. 5 MARK
LOCAL C.R.
LOCAL L.F.
SIXTH PULSE AMPLIFIER
DISTRIBUTOR INDICATOR
LINE FEED AMPLIFIER
LINE FEED SWITCH
DOUBLE LINE FEED PULSE GENERATOR
LINE FEED PULSE AMPLIFIER
CARRIAGE RETURN DELAY
AUTOMATIC C.R.-L.F. DELETE
FIGURES STORAGE CIRCUIT
STOP PULSE INHIBIT
DISTRIBUTOR DRIVE CIRCUIT
TRANSFER PULSE GENERATOR
TRANSFER PULSE INHIBITOR
TRANSFER PULSE AMPLIFIER
LINE FEED AND RECHARGE PULSE GENERATOR
RECHARGE PULSE AMPLIFIER
A,B,C DISTRIBUTOR
"A" SELECTOR GATE
"A" TRANSFER PULSE AMPLIFIER
"B" SELECTOR GATE
"B" TRANSFER PULSE AMPLIFIER
"C" SELECTOR GATE
"C" TRANSFER PULSE AMPLIFIER
MOTOR STOP STORAGE
MOTOR STOP AMPLIFIERS
CARRIAGE RETURN PULSE AMPLIFIER

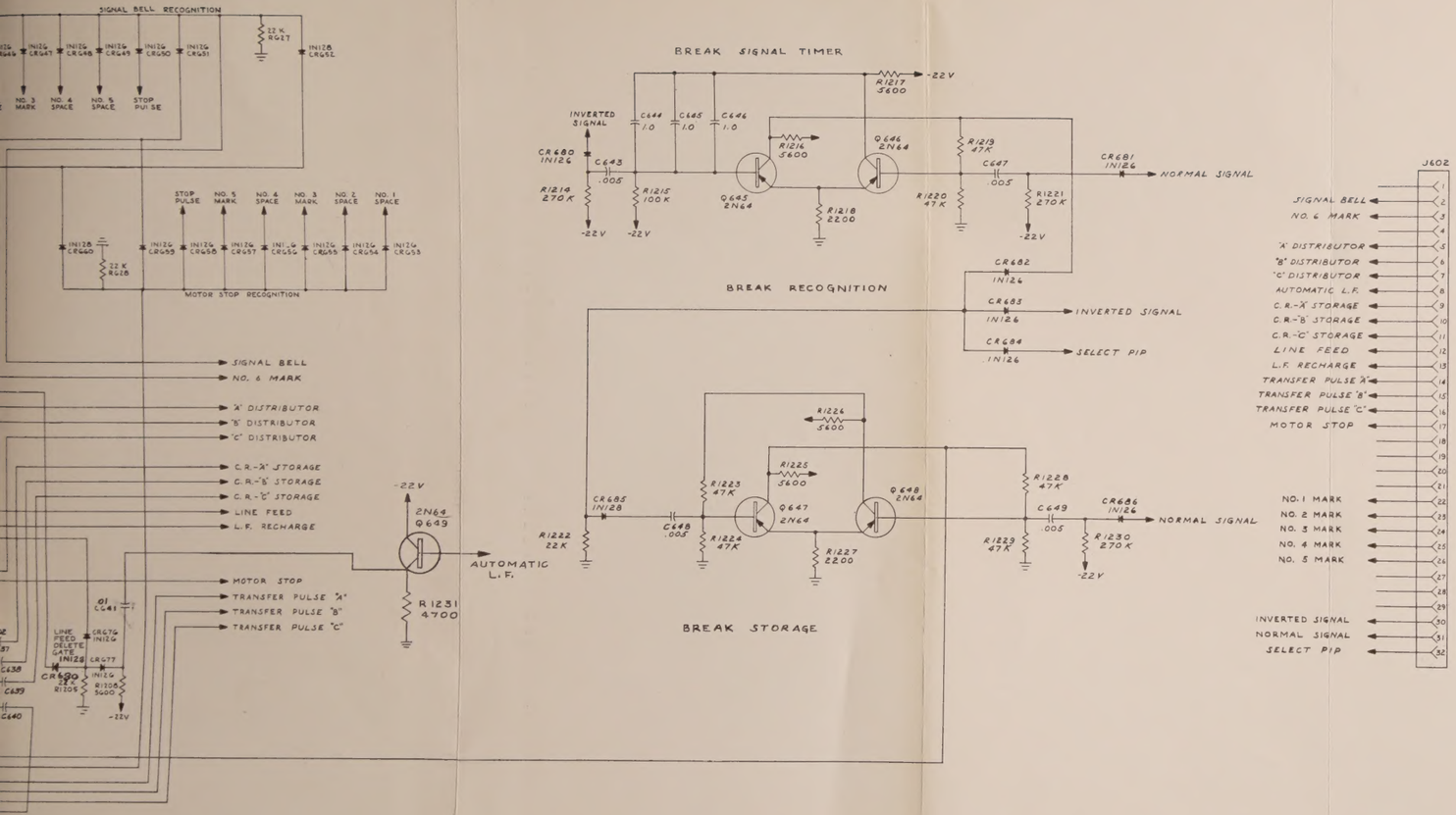


FIG 5-9
AN/FGC-36
CONTROL
UNIT
SCHEMATIC
DIAGRAM

MP MASTER
MA31860